Emergence of vocalization in non vocal children with a diagnosis of autism: building an evidence base for interventions

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Emergence of Vocalization in Non Vocal Children with a Diagnoses of Autism: Building An Evidence Base for Interventions

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A thesis submitted in fulfilment of the requirements for the
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School of Social Sciences, Education, and Social Work

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Originality Statement

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Abstract

The current study spanning 6 years 8 months reviewed technologies developed for emergence of speech in non-vocal children with autism. A total 144 children were selected of whom 126 met the inclusion criteria and completed the study. Non-vocal children between ages 1.4-13.5 years participated in four experiments that used delayed multiple baseline design across subjects. Mastery criteria for vocalization for each participant was n=7 first instances of speech. Experiment 1 studied the role of stimulus-stimulus pairing (SSP) during sign-mand training on vocal emergence in 58 participants of whom 83% acquired vocal status. Experiment 2 studied the effect of prompt-delays during sign-mand training on 3 children who failed to acquire vocals on experiment 1 for 9-33 weeks. Introduction of prompt-delays were effective in inducing vocals in all three children. Experiment 3 studied the additive effect of intraverbal training with paired auditory stimulus on 46 children who failed to acquire vocals after 12-40 weeks of sign-mand training and SSP. Results showed 80% children emerged with vocals after the introduction of intraverbal training. In Experiment 4 sign-mand training and intraverbal training with SSP were introduced together in 19 children. Results suggested 89% children emerged with vocals. Of the total 126 children across all experiments 105 emerged with vocals meeting the mastery criteria with permanent effects. Across all experiments mean IOA of the study was 89% (range 83%-94%) and treatment integrity 86% (range 57%-100%) . Retrospective data analysis suggested age of children was not a determinant for vocal acquisition and first instances of speech emerged across various verbal operants such as mands, echoic mands, echoics and intraverbals. Motivating operations accounted for 65% of initial vocals however 27% first vocals also emerged as intraverbal fill-ins. Time to vocalization, type of vocal emergence and relative successes of the technologies used are explored in this study.

Keywords: Vocalization, Autism, Time-Delay, Intraverbal training, Mand training, Stimulus-stimulus pairing, First instances of speech, inducing speech, Motivating Operations

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Chapter 1. Introduction

The prevalence of children diagnosed with autism spectrum disorder has been on the rise across the world (Dillenburger, Jordan, McKerr & Keenan, 2015; Dillenburger, McKerr & Jordan, 2015; Elsabbagh, Divan, Koh, Shin Kim, Kauchali, Marcin, Montiel-Nava, Patel, Paula, Wang, Yasamy& Fombonne, 2012; Fombonne, 2005; Fombonne, Quirke, & Hagen, 2011; Matson & Kozlowski, 2011) and is presently thought to be between 2% to 3.5% of the child population. In the Millennium Cohort Study, Dillenburger et al. (2015) conducted a parent survey on >180000 general population children born in the year 2000 in UK. The cohort of families consisting of parents, children and siblings was studied every two years on diverse topics including pre and post ASD diagnosis along with comparison data from families having a child with autism spectrum disorder and non-ASD families. As the study was longitudinal, findings suggested ratios of 1 in 111 families (0.9%) having a child diagnosed with ASD aged 5 years. At 7 years of age the prevalence was 1 in 59 families (1.7%); by 2010, at the age of 8 years the ratios were 1 in 68 children and by 2012, at the age of 11 years the rate of prevalence in the millennium cohort was 1 in 29 children with ASD i.e. (3.5%).

While clinical prevalence of autism has not been documented in India, referrals to medical professionals have increased due to language delay or speech and language regressions (Juneja, Mukherjee & Sharma, 2004; Kalra, Seth, & Sapra, 2005). Autism has been recognized as a disability only recently by the Government of India, through a bill passed in the parliament in December 2016. The formal recognition of autism in India suggests the need for societies to recognize interventions, which are evidence-based. Language delays and deficits are prevalent in 5% to 8% of children (United States Preventive Services Task Force, 2006), and 25% to 61% of individuals on the autism spectrum are non-vocal (Wendt, 2006). This thesis focuses on behavioral technologies and evaluates their effectiveness in evoking speech in non-vocal children on the autism spectrum.

1.1 The Development of Speech and Communication

Human beings communicate with each other using speech and language. Acquisition of language and communication skills is critical, as it is a behavioral cusp (Rosales-Ruiz & Baer, 1997) and the foundation skill upon which other developmental skills are built. Communication in infants begins before the emergence of speech. An infant cries to communicate his needs, which in turn are understood and reinforced by family members. However, with the development of speech the crying is soon replaced with words. During the initial stages of development of verbal skills, speech may emerge as atypical verbal repetition, and begins with producing vowel sounds and babbling. This gradually develops into a repetition of syllables, intonations and patterns of speech emitted by those around (Rogers & Dawson, 2010) to finally being replaced by meaningful words. Echoing others may eventually lead to using speech meaningfully. Language development begins with babbling phonemes in typically developing children between 4-6 months (de Villiers & de Villiers, 1978) and in behavior analysis it is considered a result of social and automatic reinforcement (Schlinger, 1995). The important independent variables responsible for increased babbling in infants are automatic reinforcement and direct reinforcement where babbling is followed by attention as a reinforcer (Bijou & Baer, 1965; Sundberg, M.L., Michael, Partington & Sundberg, C.A. 1996). By 12-18 months, children begin using first words with some intelligible speech incorporating consonant sounds (Tager-Flusberg, Rogers, Cooper, Landa, & Lord; 2009). A typically developing 2 year-old would be saying sentences with 2 to 4 words and a 4 year-old would have a vocabulary of over 1000 words put together in sentences of 4 or 5 words (Mannheim, 2015).

1.2 Language Development and Autism Spectrum Disorder

While most typical children acquire language without special instruction, and speech develops by interacting with others in the natural environment (Harlaar, Hayiou-Thomas, Dale, & Plomin, 2008), language and communication skills remain a critical and highly variable dimension of those on the autism spectrum disorder (Thurm, Lord, Lee, & Newschaffer, 2007). Deficits in language and communication are one of the core features of autism (American Psychiatric Association, 1994), with nearly a quarter of individuals with a diagnosis of autism, remaining non-verbal throughout their lives (Lord, Risi, & Pickles, 2004) and many reaching language milestones much later than typical children (Howlin, 2003).

Deficits and delays in children with autism may be due to lack of pre-requisite skills like orienting towards others, tracking faces or having inadequate joint attention and imitation (Toth, Munson, Meltzoff, & Dawson, 2006), all of which are correlated with language development and make inducing first instances of speech in children with autism conspicuously defective.

To prevent adverse effects of language deficits on the development of children with autism and other disabilities, language and communication focused interventions are recommended during early intervention programs (Moeller, 2000; Yoshinnaga-Itano, Sedey, Coulter, & Mehi, 1998). Most children with autism can be trained using specific teaching models to develop speech with substantial evidence for increasing vocalizations (Attanasio, Fitzsimons, McGregror, Meghir, & Rubino-Codina, 2012; Normand, & Knoll; 2006; Sundberg et al., 1996) through intensive behavioral interventions.

Vocalization meets the criteria for behavioral cusps as it provides opportunities for the learner to access new reinforcers and new environments, impacts significant others and reduces problem behaviors (Koegal & Suratt, 1992). In early development, children learn to communicate by learning meaningful words, which are the basis of all future listener and speaker behaviors helpful in meeting wants and desires, sharing thoughts, feelings, and developing a complex series of interactions based on verbal behavior. Most typically developing children acquire this repertoire of speaking and listening effortlessly from their immediate environments.

Various longitudinal studies indicate that children with autism spectrum disorder with speech impairments and minimal verbal skills have less favorable outcomes in life, hence development of speech and communication in children with autism, compared to “typical” population, is not only desired but also beneficial. Tager-Flusberg and Kasari (2013) reviewed several interventions targeted at improving outcomes for children on the spectrum with minimal vocals. Such interventions include behavior analytic methods such as incidental teaching, interventions using augmentative and alternative communication interventions such as Picture Exchange Communication System (PECS), sign language training and speech generating devices.

In behavior analytic literature, several technologies have been used to increase functional speech in children with low vocal-verbal repertoire. These include using echoic training with shaping (Lovaas, Berberich, Perloff, & Schaeffer, 1966); Rapid Motor Antecedent Imitation (Ross & Greer, 2003); stimulus-stimulus pairing procedures (Esch, Carr, & Michael, 2005; Miliotis, T. Sidener, Reeve, Carbone, D. Sidener, Radar, Demolino, 2012; Rader, T. Sidener, Reeve, D. Sidener, Delmolino, Miliotis & Carbone, 2014; Sundberg, M.L, Michael, Partington, & Sundberg, C.A, 1996); mand (request) training with PECS (Tincani, 2004; Tincani, Crozier, & Alazetta 2006); mand and tact training with signs, vocal prompts, with and without prompt delay (Carbone, 2012; Carbone, Sweeney-Kerwin, Emily, & Attanasio, 2010); contingent maternal vocal imitation (Pelaez, Virues-Ortega, & Gewirtz, 2011b); motherse (Pelaez et al., 2011a). A variety of interventions thus demonstrate efficacy in language development in children with autism (National Research Council, 2001; Prelock, Paul, & Allan, 2011).

Information on the number of children with ASD having the ability for spoken language is not entirely available. Initial statistics suggested nearly 50% children with ASD remain non-vocal (National Research Council, 2001). However due to modifications in diagnostic criteria, which includes many verbal children in the autism spectrum; emphasis on early intervention; and progress in techniques for improving expressive verbal (vocal) communication; the figures of non-vocal children with ASD is now considered around 25-30% (Anderson, Lord, Risi, DiLavore, Shulman, Thrum, & Pickles, 2007; Tager-Flusberg, Paul & Lord, 2005) or 10-25% (Koegal, Shirotova and Koegal, 2009). One of the more recent reports emerging out of a series of meetings organized by Autism Speaks and National Institute of Health, suggests, despite years of interventions and educational opportunities an estimated 30% children with autism spectrum disorder remain minimally vocal (Tager-Flusberg & Kasari, 2013).

Wodka, Mathy, and Kalb (2013) studied 535 children with autism and severe language delays and found that 70% of them could achieve phrase speech, of these 163 children never attained phrase or fluent speech even by 8 years of age. Given the importance of functional speech in pre-school children by age 5 and its impact on improved social outcome, one major area of interest among researchers and clinical practitioners working with children with autism is inducing vocalizations in non-vocal children with autism.

While there have been many studies on language learning per se, experimental data on non-vocal children with a diagnosis of autism spectrum disorder are relatively sparse. There are very limited studies focused on facilitating speech in children who do not echo or imitate readily and there exists variability in how non-vocal is defined. A delay in the onset of speech and communication is frequently the biggest concern voiced by parents of children with autism (De Giacomo & Fombonne, 1998) emphasizing the salience of this aspect of child development.

1.3 Contradictions in defining non-vocal

Tager-Flusberg et al. (2013) suggest the literature on minimally vocal children is both sparse and inconsistent. For example, chronologically young toddlers and pre-school children may be termed pre-verbal, which means delayed in language with potential of being verbal in the near future; while non-verbal means those who are currently not using spoken words and are expected not to use spoken language in the future. The definitions are further blurred in the following studies where non-vocal toddlers have been defined as those having less than 20 specific vocals (Yoder & Stone, 2006); 10 spoken words which can be understood, and a less than 12 months Mullen expressive language score (Romski, Sevcik, Adamson, Cheslock, et al., 2010); or having a vocal repertoire of less than 5 words (Kasari, Paparella, Freeman & Jehromi, 2008). Further examples from literature include the study of two non-vocal children of 3.6 and 5 years of age with one participant having no vocal communication or echoic verbal behavior and the second participant partially echoing some vocal sounds and syllables inconsistently (Tsiouri & Greer, 2003);

Drash, High and Tudor (1999) studied three non-vocal children with autism between 2.5-3.5 years with inconsistent vocals. Participant 1 echoed seven sounds and two words at 40% accuracy and vocal responses to prompts occurred on 70% trials.

Participant 2 echoed two sounds and three words with 25% accuracy and vocal response to prompts occurred on 53% trials. Participant 3 had four spoken words reported by the mother and imitated four sounds and five words at 54% accuracy, and vocal responses to prompts occurred on 95% trials.

The participant inclusion criteria in the study by Paul, Campbell, Gilbert and Tsiouri (2013) included spontaneous expressive vocabulary of less than 15 words, as reported by parents, with 73% of the participants having less than 5 words demonstrated through a questionnaire (Communication and Symbolic Behavior Scales-Caregiver Questionnaire) and the final selection of 22 non-vocal children.

Kodak and Clements (2009), studied the effect of echoic training in a 4 year-old boy diagnosed with autism who rarely emitted vocal verbal behavior and had no unprompted mands or tacts during baseline phase however it is not clear if the child could echo or fill-in intraverbals thereby fitting in the definition of being non-vocal.

Roche, Sigafoos, Lancioni, O'Reilly, Schlosser, et al. (2014) evaluated the impact of using a speech-generating device on two children with autism having "severe speech impairments". One male 9-year-old participant used sounds and gestures to indicate his needs, inconsistently make single word requests, and labeled at least three objects. He also repeated names of cartoon characters demonstrating echolalia while the second 3-year-old participant called for parental attention by making babbling sounds and using gestures.

A review of the literature suggests some important outcomes significant to understanding research related to inducing vocalizations in children with autism spectrum disorder with different studies adopting different definitions of vocalization. Some authors defined non-vocal as having no speech; others defined non-vocal as having some speech, but an inability to communicate. Some considered a child vocalizing some syllables as non-vocal, others classified a child able to speak less than a certain number of words as non-vocal.

The dearth of knowledge about nonverbal children with autism has been emphasized (IACC, 2011) and serious attempts have been initiated by organizations like Autism

Speaks and National Institutes of Health through meetings and workshops. This highlights the gap in understanding of the minimally verbal children with ASD.

1.4 Structure of Thesis: An Overview

The development of speech and communication in typically developing children is explored in Chapter 1 along with the possible reasons for the lack of vocal acquisition in children on the autism spectrum disorder. The chapter attempts to establish the distinction between vocal, non-vocal and non-verbal communication and elucidates variations in the definition of non-vocal in the literature.

Chapter 2 describes the evolution, conceptualization and epidemiology of autism spectrum disorder. It focuses on current prevelance rates and reviews the literature on the link between the diagnosis and vocal status of people with a diagnosis of autism.

Chapter 3 reviews the studies of professionals from a variety of fields on the development of speech, language, and communication. It deals with Skinner's analysis and taxonomy described in his book "Verbal Behavior, 1957" and elaborates the verbal operants: mands, tacts, echoics and intraverbal as units of language. The literature is reviewed on acquisition of verbal behavior based on operant conditioning.

Treatments based on the science of behavior analysis are established and recognized by various govenments and insurance agencies across the world. Chapter 4 discusses the importance of reinforcers for teaching special needs children, and elucidates the three-term, and four-term contingencies, which are units of teaching and learning. It describes the impact of operant conditioning on the behavior of individuals for increasing socially significant behaviors including vocalizing, for children with a diagnosis of autism spectrum disorder.

Chapter 5 discusses the concept of "drive" and its replacement by the behavioral term "establishing operation"; its history, and concept. The further refinement of establishing operation and its inclusion under the omnibus term motivating operations is discussed along with its types and evocative functions, its value altering and behavior altering effect on the development of verbal behavior with special emphasis in children with autism.

Chapter 6 emphasizes the dependence of verbal behavior and motivational operations on preferences. Intervention for children with autism requires identification of high value preferred items which is possible through conducting preference assessments. Various methods of preference assessment and the effect of preferred stimuli on response rate (Fisher & Mazur, 1997) are reviewed in this chapter. Finally the chapter addresses considerations on preference assessment and its relation to the selection of targets, for this study.

Behavior analytic literature includes innumerable studies focusing on the development of verbal behavior. Chapter 7 reviews the literature in detail and describes the various interventions conducted for the development of speech and language with children with autism. Several technologies including the effect of stimulus-stimulus pairing and alternative augmentative communication on vocalization outcomes are discussed and analysed in detail.

Chapter 8 provides an overview of research designs. Randomized controlled trials and single subject designs, their relevance and suitability for the experiments conducted across selected participants are discussed.

Chapter 9 provides details of methodology, research aims and objectives and data collection. A general overview of participant sampling and selection, preference assessment methods, settings, staff training, inter-observer agreement and treatment integrity methods, the dependent variable applicable for this study are described in this chapter.

Chapter 10 elaborates on four experiments conducted with non-vocal children with autism. Each experiment is followed by detailed results and graphs and includes various replications and discussions.

Chapter 11 draws final conclusions of this study, its limitations, provides a parent guidance manual and recommendations with future research ideas.

Chapter 2: Autism Spectrum Disorder

2.1 Introduction

Autism is a neurological disorder characterized by difficulties in social communication and restricted, repetitive behaviors and interests. While there are reports of persons on the spectrum overcoming some of the limitations and leading a normal life, for a majority of the affected population different degrees of life long support will be required. Autism is a spectrum disorder-affecting people in varying degrees hence the oft-heard statement no two persons with the autism are alike.

Some children with autism demonstrate a complete lack of speech; while many of those who have speech may demonstrate limited or narrow interests in conversation, may not initiate conversation, and may not be able to engage in reciprocal conversation. Distorted use of speech is observed in children in the form of echolalia which means, repeating words verbatim. For example, when asked ‘what is your name?’ a child with autism may repeat back ‘what is your name’ instead of responding with their name. Many individuals display abnormalities in eye contact, lack joint attention, may not track what is pointed, or follow eye gaze and often have difficulties in deciphering the meaning of facial expressions and body language of others. Some children as well as adults on the spectrum engage in excessive repetitive patterns of verbal or non-verbal behavior, such as nagging, preferring the same food, wanting to follow the same routes, lining up items, or engaging in motoric rituals. Often children do not demonstrate imaginative or pretend play and face difficulties in interpreting social rules. Children with autism thus have a high degree of variation across different social and communicative domains ranging from mild to moderate to severe, necessitating different levels of support depending on the degree of autism.

Lai, Lombardo, and Baron-Cohen (2014) stated that most of the adults (58-78%) with autism had very poor outcomes in terms of social relationships, employability, independent living and education before the widespread adoption of early intervention. Only a significant minority (3-25%) of children recover completely, to lose their autism diagnosis (Helt, Kelly, Kinsbourne, Pandey, Boorstein, Herbert, & Fein, 2008). However, when evaluating outcomes for persons on the spectrum, it is not an all or none situation; while some individuals will be able to lead independent and gratifying lives, the quality of life for some others impacted severely will suffer (Farley, McMahon, Fombonne, Jenson, Miller et al., 2009). Significant improvements are possible across several sub domains that fall under the broad areas of social and communication domains (Drasgow, Martin, Chezan, Wolfe & Halle, 2015) and reductions in restricted or repetitive behaviors (Cassella, T. Sidener, D. Sidener, & Progar, 2011). Under the communication domain, interventions can address a spectrum of problems, with completely mute children on one end of the spectrum and those with phrase utterances or advanced functional speech on the other end of the spectrum.

2.2 Autism – Evolution of the conceptualization and definition – Kanner to DSM 5

The definition of autism has evolved over the years and undergone several changes (Volkmar & McPartland, 2014). Leo Kanner presented a detailed description of autism based on comprehensive observations of 11 children in his paper ‘autistic disturbances of affective contact’ (1943, p. 217-50), which referred to aloof children cut off from the rest of the world facing difficulties with changes. Kanner attributed ritualistic and repetitive behaviors to the ‘insistence on sameness’. His participants also had impaired communication manifesting as echolalia, and literal use of language or idiosyncratic speech. While autism was considered to be a form of schizophrenia until 1970s, a distinction between the two was clearly established in the studies by Cantwell, Baker and Rutter (1980) and DeMyer, Hingten, and Jackson (1981). They found that while autism was seen as childhood psychosis in the mid-20th Century, the first operational definition of autism (then called infantile autism) was presented in DSM – III (Diagnostic and Statistical Manual of Mental Disorders) in 1980. It was influenced by Michael Rutter’s (1978) delineation of autism onset before 30 months of age, characterized by impaired social development, communication development and insistence on sameness. The revision in DSM III- R involved a change in name from infantile autism to autistic disorder to ensure that the focus was not limited to very young children. In the DSM III-R edition, 16 detailed criteria spanned three major domains i.e. communication, reciprocal social interactions, and restrictive interests. For a diagnosis of autism, at least 8 criteria had to be met with at least 2 from social and one each from other criteria. The DSM III-R and all subsequent volumes had only one book to meet the requirements of research and publication and clinical description and assessments.

The DSM IV (1994) sought to arrive at criteria that would strike a balance between clinical and research requirements, and the term Pervasive Development Disorder (PDD) was used as an umbrella term under which specific disorders were defined. Subsequently DSM IV-TR (2000), had five 5 subcategories of ASD under PDD, namely autism spectrum disorder, Asperger's, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (PDD-NOS). Guidelines for DSM IV-TR specified the following use:

A. Autistic disorder diagnosis would be confirmed if at least 6 out of the 11 criteria under the following triads of impairment were met with at least 2 from qualitative impairment in social interactions and one each from the other two.

  1. Qualitative impairment in social interaction, as manifested by at least two of the following:
     - i. Marked impairment in the use of multiple non-verbal behaviors such as eye gaze, facial expression, body orientation, gestures and postures to regulate social interaction.
     - ii. Failure to develop peer relations appropriate to developmental level
     - iii. A lack of spontaneous seeking to share enjoyment, interest, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest.
     - iv. Absence of of social or emotional reciprocation.

  2. Qualitative impairments in communication as manifested by at least one of the following:
     - i. Delay in, or total lack of the development of spoken language (not accompanied by an attempt to compensate through alternative communication such as gestures or mime.

ii. In individuals with adequate speech, marked impairment in the ability to initiate a conversation with others and sustain it.
iii. Stereotypic use of idiosyncratic language.
iv. Lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level.

3. Restricted repetitive and stereotypic patterns of behavior, interests, and activities, as manifested by at least one of the following;
   i. Encompassing preoccupation with specific interests, which may be stereotypic and abnormal either in intensity or focus.
   ii. Apparently inflexible adherence to specific, nonfunctional routines or rituals.
   iii. Motor mannerisms, which may be repetitive or stereotypic (e.g., hand flapping or finger twisting, or body movements).
   iv. Persistent preoccupation with parts of objects.

B. Delays or abnormal functioning in at least one of the following criteria, with onset prior to age 3 years:
   i. Social interaction
   ii. Language as used in social communication, or
   iii. Symbolic or imaginative play.

In 2013, the DSM 5 further modified the definition of Autism Spectrum Disorders, i.e., the term Autism Spectrum Disorder (ASD) is now used to encompass autism spectrum disorder, Asperger's, childhood disintegrative disorder, and PDD-NOS. ASD is characterized by a dyad of impairments:

   i. Deficits in social communication and social interaction and
   ii. Restricted repetitive behaviors, interests and activities (RRBs).

An individual is diagnosed with ASD only if both of these components are observed. If an individual does not exhibit RRB, the diagnosis is Social (Pragmatic) Communication Disorder. The definition of ASD is significant in this study as the participants were selected between the years 2010 – 2015, and diagnosticians provided diagnosis based on DSM-IV criteria.

2.3 International Classification of Disease (ICD)

The World Health Organization (WHO) provides a standard diagnostic tool, the International Classification of Disease (ICD) for medical professionals and others related to the health profession in 43 languages. Its current edition ICD-10 (World Health Organization, 1990), places ASD under pervasive development disorder (PDD) within a broader category of mental and behavioral disorders (WHO, 2013) including ten subcategories. These include: childhood autism, atypical autism, other childhood disintegrative disorder, overactive disorder associated with mental retardation and stereotyped movements, Rett's syndrome, Asperger's syndrome, other pervasive developmental disorder, and pervasive developmental disorder unspecified.

The DSM-IV (American Psychiatric Association, 1994) and ICD-10 (World Health Organization, 1990) over successive iterations had many similarities, and correspond to a high degree in their diagnostic criteria (Fombonne, 2005). Medical professionals for diagnosis purposes use these manuals. Within the DSM-5 (American Psychiatric Association, 2013) the latest revision of previous classifications has replaced the subgroups to include one diagnostic category i.e. autism spectrum disorder which includes a dyad of impairments i.e. a) impaired social communication disorder and b) restricted and repetitive behaviors. The DSM-5 no longer includes Asperger's or PDD-NOS under its category.

2.4 Epidemiology and Prevalence of Autism Spectrum Disorder

The number of children being diagnosed with autism spectrum disorder has grown in the last 15 years and is serious enough to generate considerable debate at government levels leading to national policies on autism making the current study highly relevant. Once considered a rare condition with a prevalence (i.e. the total number in a population at a given time) of about 2-4 per 10,000 children (King & Bearman, 2009), between 2000 and 2010, the prevalence published by Center for Disease Control and Prevention (2014) has steadily climbed from 1 in 150 to 1 in 68. Researchers worldwide have addressed the issue of prevalence in their populations (Fombonne, 2005; Gillberg & Wing, 1999; Wing & Gould, 1979). Baird, Simonoff, Pickles, Chandler, Loucas, Meldrum, and Charman, (2006) have reported prevalence of 116 per 10,000 children in South Thames region of London and this excluded children in mainstream schools. Kadesjo, Gillberg, and Hagberg (1999) reported 120 per 10000 in Karlstad, Sweden. A study in South Korea by Kim, Leventhal, Koh, Fombonne, Laska, and Cheon (2011) using international diagnostic criteria reported prevalence to be 2.64% (1 in 38). A more recent longitudinal study in United Kingdom by Dillenburger, et al. (2015) used data from the "Millennium Cohort Study" (MCS), a parent survey on a large-scale population of >180000 children for those born in the year 2000. The study concluded higher rates of prevalence of ASD at 3.5% (1 in 29) among 11 years old as compared to 0.9% when children from the MCS were 5 years old. The prevalence rate in Northern Ireland was 2% in school children (DHSSPS, 2014) an estimated 1 in 88 across all age groups (CDC, 2014). The World Health Organization in their January 2016 fact sheet, state 1 in 160 children have a diagnosis of ASD. All the above studies have indicated a rising trend of prevalence rates.

Apart from the probability of a real increase in prevalence due to genetic and environmental factors, some increase in prevalence has also been attributed to the evolution of terminology, changing diagnostic criteria, differences in study methodologies and increasing awareness of ASD (Wing & Potter, 2002).

It is noteworthy that while the Government of India recently recognized ASD as a disability (2016), there is only one report, on ongoing prevalence studies for PDD in India (Elsabbagh, et al., 2012), and there is considerable lack of critical information, required for planning services. Despite the changes in the definition of autism and ongoing debate about prevalence (Gernsbacher, Dawson, & Goldsmith, 2005; Baxter et al., 2014) the global rise in the diagnosis of autism is an established fact with the annual societal cost for people with autism in United States and United Kingdom exceeding billions (Ganz, 2007). The pronounced increase in the number of children with ASD imparts urgency amongst researchers to identify causes, build preventive measures, build capacity of caregivers and identify effective interventions for meeting the needs of the ASD population.

2.5 Autism Spectrum Disorder and Vocalizations

Half of all children with a diagnosis of ASD are functionally mute (National Research Council, 2001; Peeters & Gillberg, 1999; Prizant, 1983; Rutter, 1968), with delayed language and deviant communication (Cantwell, Baker, & Rutter, 1978) however subsequent researchers have provided lower percentages of non-verbal children on the autism spectrum such as: 25-30% (Anderson et al., 2007; Tager-Flusberg, et al., 2005); 10-25% (Koegel et al., 2009); and 30% (Tager-Flusberg, et al., 2013).

While delays in acquisition of speech may be linked to cognitive skills (Bartak et al., 1975) an inability to communicate wants and desires also leads to challenging behaviors such as aggression, tantrums and self-injury. As most interventions for behavior reduction focus on functional communication training (Carr & Durand, 1985; Tiger, Hanley, & Bruzek, 2008; Wacker, Harding, Berg, Lee, Schieltz, et al., 2011); it suggests the importance of vocalizations, speech and communication in children with autism. An ability to vocalize is pivotal to the quality of life of a person with autism.

2.6 Summary

This chapter highlights the increasing prevalence of autism and the serious difficulties faced by many children due to delayed language. While understanding the core deficit of autism is important, studying the literature on language development and the contribution of various sciences to this understanding holds significance. The next chapter reviews the linguists', psychologists' and the behaviorists' view on the development of vocal-verbal behavior.

Chapter 3: The Analysis of Spoken Language

3.1 Linguists and Language Development

Language acquisition in humans has been a topic of interest in many fields of study. The development of language is traditionally considered a subject matter that concerns the linguist. The linguist analyzes the topography of language by an analysis of the form and structure of language like phoneme, morpheme, lexicon, syntax and symantics to establish a formal analysis of language. The phoneme is the basic unit of language, and the morpheme the basic "meaningful" unit. Linguists are involved with the study of grammatical structure and the meaning of the verbal response products, and these do not consider the context in which the words are produced making linguistic descriptions less adequate for applied work (Esch, B.E., LaLonde, & Esch J. W., 2010). Their explanations of language is based on "form", and does not address "function" of language to explain why an individual uses certain words when he speaks, why he communicates and what can be done to develop language (Hall, 1992; Knapp, 1990).

3.2 Traditional Psychologists and Language Development

Psychologists like Brown (1973), Piaget (1926), or Slobin (1973) identified cognition as an explanation for the development of language. They considered "mental events" or "thoughts" as mediating events, controlled by feelings, ideas, meanings, and intentions, which in turn were responsible for speech and language. In traditional psychology, language is believed to be controlled by internal cognitive processing systems, that accept and classify information, code, decode and store verbal information. Psychologists examined language as either receptive or expressive; controlled by cognitive processors. Currently this framework based on the cognition theory dominates language intervention programs for children with autism (Hall, 1992).

Chomsky, (1965) and Pinker, (1994) proposed that in humans language was innate, a result of physiological processes and environmental events like reinforcement and stimulus control, had no effect on language development. Heather, Lely and Pinker

(2014) suggest that genes had an effect on the brain circuits, and the understanding of language in the 21st century will be enhanced by data collected from individuals with developmental disorders including autism. It is significant to note here that there are no practical applications of either Chomsky or Pinker's analysis to language development in autism.

3.3 Behavior Analysis and Language

In his book on "Verbal Behavior", Skinner (1957) went beyond these conceptualizations and became the first to suggest a function-based analysis of language development. Skinner emphasized that, language like any other behavior is learned, and under the functional control of environmental events like deprivation or aversive stimuli. Verbal behavior receives reinforcement through direct contact with the environment, and behavioral procedures like reinforcement, motivating operations, shaping, discriminative stimuli, and stimulus control affect language acquisition and development (Sundberg, 1979). The causes of verbal behavior were observable and measurable unlike hypothesized internal processes mentioned by biological and cognitive analysts.

The analysis of language as conceptualized by Skinner is different from the analysis provided by linguists. Linguists analyzed language by its structure or parts of speech, or "form"; whereas behavior analysts researched language development as any other learnt behavior maintained by consequences and derived reinforcement due to the mediation of another person. The analysis was unique and provided no cognizance to hypothetical constructs for language acquisition such as internal cognitive processes, which included coding, decoding and storing verbal information (Hall & Sundberg, 1987). In a study on linguistic behavior and interaction between speaker and listener Bijou, Umbreit, and Ghezzi (1986) concluded social interactions are measurable and can be applied with various populations including families of special needs children.

3.4 Vocal, Non-vocal, Verbal and Non-verbal

Literature is strewn with inconsistencies in the use of the terms vocal and verbal or non-vocal and non-verbal, often creating confusion among readers. Skinner (1957) clearly differentiated these terms. He defined vocal behavior as the ‘production of auditory stimuli resulting from the movements of the muscles of the vocal apparatus’ (Carbone, 2012). Consequently, non-vocal referred to those who currently do not use spoken words and are likely to remain non-vocal in the future (Tager-Flusberg et al., 2013). While linguists use the term ‘verbal’ synonymous with spoken language, a Skinnerarian taxonomy of ‘verbal behavior’ uses the term in a more general context of social communication, where verbal behavior, vocal and non-vocal topographies differ from non-verbal as verbal behavior typically refers to ‘behavior reinforced through the mediation of other persons’ (Skinner, 1957).

This definition was a first attempt to describe language as behavior and according to Palmer (2008) was redefined by Skinner to include contingencies arranged by a verbal community. The definition found many critiques (Hayes, 1994) in the field of behavior analysis, as it was broad and nonfunctional. Skinner (1957) referred to ‘listener responding’ as verbal, including responses made by a listener during interactions, i.e., closing the door when a speaker asks. While this behavior of the listener may reinforce the speaker’s behavior, some other behaviors like a warning signal from a passer-by not to go close to a dangerous animal in a zoo may have no direct consequence for the speaker (Palmer, 2008). Similarly some behaviors may act on the environment to produce consequences; such as the behavior of a vigorous dancer who broke the stage, may not be considered verbal behavior, as the consequence is not mediated.

According to Skinner, vocalizing something, or saying a word, is not the same as verbal behavior. Skinner’s use of the term ‘verbal behavior’ includes all forms of responses including speech, sign language, gestures, written words, symbols (Culotta & Hanson, 2004) and distinguishes from speech pathologists’ use of the term ‘vocal behavior’ which is the ability to produce sounds and the traditional psychologists’ use of the term ‘non-vocal communication’ for gestures and signs. For Skinner, asking someone for a glass of water using vocals, sign language, written word, or gestures would be termed verbal behavior.

3.5 Verbal Behavior

Skinner (1957) emphasizes language as operant behavior controlled by antecedents and consequences and defines verbal behavior as behavior, which is effective only through the mediation of another person. A person can get a glass of water for himself and thus contact the reinforcer (i.e. drinking the water) or he can say/sign/write, “get me a glass of water”, and achieve the same result indirectly, through another person’s mediation. When a person engages in verbal behavior, this behavior is reinforced by the behavior of the person who is verbally (through vocals, signs, gestures, in written form) engaging with him. Thus, the analysis of verbal behavior concerns itself with the effect a speaker’s behavior has, on a listener’s behavior.

> ‘Much of the time, however a man acts only indirectly upon the environment from which the ultimate consequences of his behavior emerge. His first effect is upon other men. Instead of going to a drinking fountain, a thirsty man may simply “ask for glass of water” – that is, may engage in behavior which produces a certain pattern of sounds which in turn induces someone to bring him a glass of water. The sounds themselves are easy to describe in physical terms; but the glass of water reaches the speaker only as the result of a complex series of events including the behavior of a listener’.
>
> (Skinner, 1957, p.1)

Skinner’s emphasis on distinguishing between the behavior of the speaker and listener contrasted with other approaches. Skinner primarily focused on the speakers’ behavior whereas linguists used terms like receptive language and expressive language to describe communication. As a child with autism needs to learn to respond verbally as a speaker and also respond to verbal stimuli from others, Skinner distinguished between both on the basis of functional relations. As autism is a spectrum disorder, some children with autism learn to request for things they want, (e.g., “give me a chocolate”); however do not respond when asked to name or label an item (e.g., saying “chocolate” when shown a piece of chocolate and asked “what is this?”). On the other hand, some learn to label common items, (e.g., saying, “this is a cup”), although they might be unable to request for it (e.g. saying “give me cup” when they need a cup). This suggests, distinguishing language as receptive and expressive does not isolate the cause, as to why, some children could speak “cup” when shown a cup and asked, “what is this?” but not when they wanted the “cup”. Thus, Skinner’s analysis of verbal behavior emphasizes the functional unit of language as a basis for language development.

Irrespective of whether verbal behavior is vocal or non-vocal, Skinner distinguished between the “form” and “function” of behavior. The form describes what the behavior looks like, while function describes the purpose it serves for that individual. For example, a child who is non-vocal may grab toys from peers. Here, grabbing is the “form” or topography of behavior, which served the “function” of communicating “I want to play with toys”.

3.6 Verbal Operants – The Units of Verbal Behavior

Skinner (1957) developed the taxonomy of seven elementary verbal operants defined by their function. These are (1) Echoic (2) Mand (3) Tact (4) Intraverbal (5) Textual (6) Transcription and (7) Copying a text. The unit of analysis of verbal behavior is the functional relation between a type of responding and the same independent variables that control nonverbal behavior, namely a) motivating variables b) discriminative stimuli and c) consequences. This unit is referred by Skinner (1957, pp.19-22), as a verbal operant where the operant is a class of behaviors, different from an instance of response. Skinner explains this, by an analysis of words and their meaning, versus the verbal operant (pp. 187-188). A word whether written or spoken, may have a particular meaning however, may belong to a different verbal operant based on the functional relation between the controlling variable and consequences. For example the word “water” means “a colourless, transparent, odourless, liquid which forms the seas, lakes, rivers and rain and is the basis of the fluids of the living organism” (Oxford dictionary), however the word “water” can be used across verbal operants based on the function it serves, (i.e. getting to drink “water”, labeling “water”, saying “water” when someone says name a drink, or echoing “water” when someone says water). This description of a word, as a behavioral functional unit, has great significance in training children with autism and is enumerated in further detail.

3.6.1 Mand

The term ‘mand’ is derived from the word “demand”, “command” or “countermand”. Mand is a verbal operant (Skinner, 1957, pp. 35-51) in which the verbal response (i.e., what a person speaks) is under the functional control of what one needs (i.e., the motivating operation). The mand is specifically reinforced by what was requested for, e.g., manding for a book results in getting a book, asking for directions will get the information on directions, and a mand for someone to move will get the person to give way. A speaker wanting information may ask questions like “where are my crayons?” “when will we go out?”, “who is at the door?”, “which book do you want me to fetch?”, “how did you make this cake?” or “why are you late?”. These examples demonstrate that being deprived of information when one needs it leads to functional language. Aversive conditions also create a motivating operation for using language. For example if the volume of music is too high and considered aversive, the person may ask for a reduction of the volume or if a task or activity is difficult or tiring it creates a condition for asking for a break. Using language so that the aversive condition is removed provides necessary reinforcement to the speaker.

Commonly, mands are evoked when individuals are deprived of an item (i.e., through an establishing operation) or an aversive condition through an abolishing operation. A mand produces access to reinforcers and thus directly benefits the speaker. The listener provides the reinforcer to the speaker by delivering what is requested, making early language acquisition in infants operant in nature (Moerk, 1990; Pelaez, Virues-Ortega, & Gewirtz, 2011b). Thus mands develop prior to any other verbal operant in early language learners (Bijou & Baer, 1965; Lerman, Parten, Addison, Vorndran, Volkert, Kodak, 2005; Sundberg, 2007), whether it is asking or requesting others for an item, activity or information (Drash, High, and Tudor, 1999).

Skinner (1957) suggested that the earliest sounds of an infant are made in a state of deprivation and these can be conditioned as verbal operants when a listener provides the reinforcer. This leads to a reinforcement history of using language. Early sounds from an infant can thus be considered requests or mands (Bijou, 1993; McLaughlin, 2010; Novak & Pelez, 2004; Schlinger, 1995; Skinner, 1957). All verbal behavior made in the form of a mand primarily benefits the speaker, as mands are made in the presence of a listener who provides reinforcement to the speaker.

For children with autism who exhibit language delays it is recommended that intervention programs should begin with mand training (Greser & Ross, 2008; Sundberg & Partington, 1998; Sundberg & Michael, 2001) and therefore, language acquisition programs for most children with autism begin with mand training (Drash, High, & Tudor, 1999; Kelley, Shillingsburg, Castro, Addison, & LaRue, Jr. 2007).

3.6.2 Tact

Tact is defined as a verbal operant in which a response of a given form is evoked by a particular object, event, or the property of an object or event (Skinner, 1957). The verbal operant is under the control of a non-verbal stimulus like an object, picture, event, person or its characteristics and maintained by generalized reinforcers like attention from another person or tangibles in the form of edibles, toys, tokens or a prize. For example a child sees an aeroplane and says “Aeroplane”. In a tact the controlling relation is governed by being in contact or being in the presence of stimulus which evoke verbal response; whereas in a mand deprivation or an aversive stimulus serves as the controlling variable (Laraway, Snycerski, Michael, & Poling, 2003). Some further examples of tacts are when asked “what colour is this car?” in the presence of a car evokes the response “red”. Saying “hot” when tasting a hot soup, saying “this bag is heavy” while lifting a shopping bag, “this blue dress is beautiful”, “the glass is full”, “he is my dad”, “she is running fast”, “that smells good” or “this teddy is so soft” are all verbal responses where the controlling stimulus is the picture, person or property of an item or an action. A therapist holding a picture of cat may evoke a response “cat” and the therapist may provide praise for labeling the picture correctly.

Tact, can also be under the control of private events with which only the speaker can connect. Saying, “I have a toothache” or “I need to use the toilet” is based on the private world, which the speaker can relate to and is similar to how s/he relates to the outside world. The ability to speak and verbalize such events is part of the development of verbal behavior. Tacts are part of language under the functional control of a discriminative stimulus.

As many children with autism have difficulties with language development and do not derive reinforcement from other people due to a lack of joint attention, vocalizations may not emerge as tacts. Children label things/events not for the sake of labeling but also for the attention (mand) they derive by doing so. Most children with autism do not derive such reinforcement from their environments suggesting the functional independence of mands and tacts (Neef, Walters, & Egel, 1984; Shillingsburg, Kelley, Roane, Kisamore, & Brown, 2009).

3.6.3 Echoic

An echoic is a verbal operant defined as a 'verbal stimulus which is under the control of verbal stimuli' where the response generates a sound pattern similar to that of the stimulus (Skinner pp. 55). In an echoic the word has point-to-point correspondence that is; the initial, medial and the end part of the word are repeated exactly, e.g. if an adult says "zebra", the child repeats "zebra". Another significant characteristic of the echoic is the temporal relation between the word presented (stimulus) and the response made, e.g., delayed re-production of the speech would not be echoic.

Echoic training or vocal imitation is a way to induce vocalization in non-vocal children including those with developmental disabilities and autism. It may be taught by asking a child to repeat any word or sound not necessarily based on what one wants (Lovaas, Koegel, Simmons & Long, 1973; Ross & Greer, 2003), and providing direct reinforcement for repeating them.

3.6.4 Intraverbal

Intraverbal refers to verbal behavior evoked by a verbal discriminative stimulus and maintained by generalized reinforcement. Further, the response does not have point-to-point correspondence with the verbal stimulus, which evokes it (Skinner, 1957, p.71) i.e., the stimulus and the response do not match and are not composed of the same verbal units (Sundberg & Michael, 2001). For example when someone says, "Twinkle twinkle little" and the other person says "star" the fill-in "star" is an intraverbal response. Another example is when someone asks, "How are you?" The response "fine" is intraverbal. There is no topographical correspondence between the initial statement and the response.

Empirical research has shown that some children with autism acquire words and learn to tact when presented with an object or picture, point at it (receptive language) when asked "which one is pencil?" and even mand for it when they need it, however may not be able to respond with the word “pencil” when asked “what do you write with?” They will mand and tact but may not respond under the control of the intraverbal operant (Bram & Poling, 1983; Luciano, 1986; Partington & Bailey, 1993). The intraverbal verbal relation builds language skills leading to conversation skills, providing an individual an opportunity to talk about things and events that are not physically present.

3.6.5 Textual, Transcription and Copying a Text.

The elementary verbal operants described by Skinner also included Textual which is a type of verbal behavior where written stimuli control vocal-verbal behavior. Reading or finger spelling printed words demonstrates point-to-point correspondence between the stimulus and response product. Transcription is an elementary verbal operant that involves evocation of a written, typed or finger spelled response when a verbal stimulus is presented. It has point-to-point correspondence however no formal similarity. Examples of transcription include taking a dictation. Copying a text is an elementary verbal operant, which involves a response evoked by a verbal discriminative stimulus that has point-to-point correspondence and formal similarity. The latter two verbal operants have no effect on vocalization.

3.7 Building Functional Speech

Lovaas (1977) pointed out the problems faced by early behaviorists in teaching language where words and parts of speech were taught using behavioral methods and did not lead to initiations (mands) in natural environments. In typically developing children language acquired under the controlling conditions of one verbal operant transfers without direct instruction to another verbal operant (Hernandez, Hanley, Ingvarsson, & Tiger, 2007; Nuzzolo-Gomez & Greer, 2004; Rosales & Rehfeldt, 2007). This means a word acquired as a mand without formal teaching will be used as a tact or an intraverbal. For example; If a child learns to ask for “ice-cream” i.e., mand, he will also be able to tact ‘ice-cream’ when asked to label it, or say “ice-cream” when the verbal stimuli is “I want to eat something cold”. This is important, as the emergent verbal behavior, for example a mand when transfered to an echoic or tact, may build functional speech for communication.

While early research supported the functional independence of mands and tacts (Hall & Sundberg, 1987; Partington, Sundberg, Newhouse, & Spengler, 1994; Twyman, 1996), recent research focused on “emergent” verbal behavior i.e., the transfer of learning from one operant to another (Arntzen & Almas, 2002; Petursdottir, Carr & Michael, 2005; Wallace, Iwata, & Hanley, 2006) for building language in those with speech deficits.

3.8 Differentiating between Verbal Operants

Skinner, elaborated on the verbal operant as a unit of analysis by suggesting that even though the topography of the response made by an individual may have the same form, it may be a different type of verbal operant. This means that a person might use the same word but it may not serve the same function in different contexts.

Emergent verbal behavior in which a response acquired under the controlling conditions of one verbal operant transfers to another verbal operant without direct instruction is the key to language development. However, the distinction between the tact and the mand is important when considering function in language development. Hall and Sundberg (1987) in their experiment with 2 participants taught them to complete a response chain by tacting several items needed for a task. Results suggested the participants learnt to tact all items, however did not mand if an item was missing. Sigafoos, Doss and Reichle (1989) implemented tact training for 3 participants for a food, and a utensil to consume it. On mand probes, the participant did not request till the utensil was held up and the experimenter asked, “What is this?” Stimulus control was gradually transferred from tacts to mands. Finn, Miguel and Ahern (2012) in their study with four boys with autism aged 3 to 6 year old, evaluated the functional independence of mands and tacts. Two boys were taught to mand and two were taught to tact two 4-piece constructs e.g. “It's a” or “I need a”. Results suggest three participants demonstrated an immediate transfer of control from one operant to another. Wallace, Iwata and Hanley (2006) taught 3 participants with developmental disabilities to tact items with highest and lowest preferences, and subsequently tested for mands. All participants manded for highest preferred while the manding for least preferred gradually dropped. These results indicate that tact and mand functions differ and have several implications for teaching communication skills to individuals who have severe communication deficits. Mand training and requesting is often the initial focus with individuals with developmental disabilities (Dixon, Small & Rosales, 2007; Sautter & LeBlanc, 2006) as it benefits the concerned individual. During other experiments participants displayed emergence of untaught tact responses following mand training (Hernandez, Hanley, Ingvarsson, & Tiger, 2007; Nuzzolo-Gomez & Greer, 2004; LaMarre & Holland, 1985) and the emergence of echoics from mands (Drash, High, & Tudor, 1999).

3.9 Summary

This chapter highlights the important of the functional use of words, and provides innumerable applications of "verbal behavior" with those on the spectrum. With specific reference to children with autism, mands have been clearly identified as the choice of treatment for teaching communication including early intervention programs. While linguists have provided a detailed analysis and structure of language, they have been unable to provide concrete methods for teaching non-vocal children with autism (Esch, B.E., La Londe, Esch, J. W., 2010). In the next chapter the science of behavior analysis is discussed along with teaching units for skill acquisition and its revelance in teaching children with autism.

Chapter 4: Applied Behavior Analysis

4.1 Introduction

The basic principles underlying applied behavior analysis (ABA) draw from the research of B. F. Skinner (1938). He theorized that behavior was established by a process called selection by consequences, and demonstrated that favorable outcomes increased and maintained behavior while non-favorable consequences diminished or decreased it (Alberto & Troutman, 2009). Earlier definitions of ABA by Baer, Wolf and Risley (1968) led to the current definition as follows:

> 'Applied Behavior Analysis is the science in which tactics derived from the principles of behavior are applied systematically to improve socially significant behavior and experimentation is used to identify the variables responsible for behavior change'.
>
> (Cooper, Heron, & Heward, 2007, p. 20)

Methods and techniques derived from the science of ABA find application in several socially important domains such as early intensive behavioral interventions for children with autism (Fester, 1961; Ghezzi, Williams, & Carr, 1999), pharmacology (Laties, 2003), space program (Brady, 2001; Rohles, 1992), gerontology (Gallagher & Keenan, 2000), industrial safety (Fox, Hopkins, & Anger, 1987), zoo management and animal care (Forthman & Ogden, 1992), environment sustainability (Krantz. & McClannahan, 1994), language acquisition (Galizio, 2003; Drasgow, Halle, & Ostrosky, 1998), sports training (Brobst & Ward, 2002) , and animal training (Breland & Breland, 1951; Pryor, 1975) .

The science of behavior analysis comprises of Behaviorism, the philosophy of science of behavior; Experimental Analysis of Behavior (EAB) that deals with basic research on behavior; and Applied Behavior Analysis (ABA), which encompasses technologies for improving behaviors of social significance. ABA can be understood only in the context of behaviorism and experimental analysis of behavior where basic and applied domains of the science translates knowledge derived from basic science for implementation in applied settings for improvements in society (Lerman, 2003, p. 415).

From a historic perspective, the early 1900s investigations into human behavior were primarily comprised of analyses of states of consciousness, and mental processes. John B. Watson (1924) brought observable behavior into focus and referred to its importance as a subject matter of study. His proposition to identify environmental stimuli (S) and the responses (R) they evoke came to be termed Stimulus-Response or S-R psychology.

The experimental analysis of behavior began with exploring a class of behaviors, which were involuntary responses to stimuli (e.g., pupil dilates when shown a bright light). This pioneering work on respondent conditioning by Watson and Pavlov was built upon through painstaking research by Skinner to study the effects of consequences on behavior termed operant conditioning. During this period the use of hypothetical constructs such as drive, free will, and cognitive processes were rejected and termed mentalistic due to the belief that the origins of behavior were an inner state (Dixon, Vogel, & Tarbox, 2012). Skinner incorporated the inner state of thoughts and feelings as private events guided by the same principles as observable behavior. The inclusion of all behaviors public and private under the term radical behaviorism provided a philosophical basis through which mentalistic understanding of behavior could be avoided (Cooper et al., 2007).

Applied behavior analysis uses principles derived from the laboratory and applies them to human subjects. The functional relationship between environmental variables, such as antecedents and consequences, is the key to understanding influences on behavior (Emerson, 2001). This relation between antecedents, behaviors and consequences has been depicted by the three-term contingency as follows:

Antecedent Stimulus →	Behavior →	Consequence	Future Occurrence of Behavior	ABA Principle in Operation
Fix the puzzle	Task completed	Super Job !	↑	Positive Reinforcement
Starts raining	Pick the umbrella	Escape the rain	↑	Negative Reinforcement
Toy taken back	Hitting	Blocked hands	↓	Positive Punishment
Traffic Signal Red	Drive through	Pay a fine	↓	Negative Punishment

Operant conditioning involves establishing a functional relationship between behavior and consequence in the three-term contingency. However reinforcement as consequence strengthens the behavior-antecedent relation as well. For example the infants behavior of saying “mama” in the presence of his mother provides the infant access to a range of reinforcers (e.g. hugging, cuddling, smiling) from his mother. At the same time, saying “mama” in the presence of the mother and no one else has resulted in the mother becoming a discriminated operant due to the consequences provided previously. Eventually presence of mother increases the future probability of a class of behaviors (e.g. calling, crying, requesting, nagging) of the infant due to operant conditioning. The three-term contingency is a basic unit of analysis also termed the ABC of behavior analysis of operant behavior (Glenn, Ellis, & Greenspoon, 1992, p 1332).

4.2 Increasing Behaviors

The principle of reinforcement forms the bedrock of applied behavior analysis. Reinforcement refers to the process by which a behavior is strengthened, and maintained, by a consequence that reliably follows a behavior, and increases the likelihood of its future occurrence (Foxx, 1982a, Michael, 2004, p.30). There are two distinguishing types of reinforcement i.e. positive and negative reinforcement. Positive reinforcement is concerned with the addition of a stimulus, and negative reinforcement includes withdrawal of a stimulus following a behavior. Both result in the future increase in the frequency of behaviors (Cooper et al., 2007).

Some other factors that affect a person’s future increase in behavior are immediacy in the availability of reinforcement (Malott & Trojan Suarez, 2004; Sidman, 1960), density of reinforcement (Neef, Iwata, & Page, 1980), and reinforcer rate, delay and quality (Hoch, McComas, Johnson, Faranda, & Guenther, 2002; Neef, Mace, Shea, & Shade, 1992; Neef, Mace, & Shade, 1993). Schedules of reinforcement too play a significant role in individual responses (Binder, Dixon, & Ghezzi, 2000; De Luca & Holborn, 1992; Dixon & Holcomb, 2000; Martens, Lochner, & Kelly, 1992; Reid, Parsons, Green, & Browning, 2001) and their maintenance. It is thus proven that consequences influence future occurrence of behavior.

4.3 The Four-term Contingency

The discovery of the importance of motivating operations (Michael, 2007) as an antecedent variable resulted in expansion of the three-term contingency to the four-term contingency. Reinforcement is related to motivation and has a strong impact on behavior (Hall, Lund, & Jackson, 1968; Patel, Piazza, Martinez, Volkert, & Santana, 2002). Motivating operations refer to the ability of an environmental variable, to affect the value of a consequence, either by strengthening or weakening behavior therby altering the current frequency of all behaviors previously reinforced by that consequence. For example, a period of slight starvation makes snack more valuable as a reinforcer and strengthens behaviors leading to asking for snacks. It can be depicted as follows:

MO $\longrightarrow$	S^D $\longrightarrow$	R $\longrightarrow$	S^{R+} $\Uparrow$
Child missed snack	Apple on table	Eat apple	Feel $\Uparrow$ good

If the child in the above example had recently consumed his meal the sequence of behavior may not have possibly occurred. Motivating operations thus hold the key to the effectiveness of behavioral interventions as they directly affect the strength of consequences that subsequently affect the strength of behaviors.

4.4 Support for ABA Based Interventions for Autism Treatment

Amongst the strongest endorsements for the effectiveness of applied behavior analysis-based interventions for skill-building and reduction of inappropriate behavior, in persons with autism comes from the Surgeon General of United States (1999), who referred to thirty years of research that demonstrates the efficacy of ABA based interventions. The National Autism Center (2009) identifies 14 interventions as established and evidence based. These interventions such as modeling, naturalistic strategies, comprehensive behavioral treatment for young children, schedules, scripting and self-management, are all interventions based on the scientific findings from ABA.

Myers, and Johnson (2007) in their clinical report in American Academy of Pediatrics have concluded that children with autism who received early and intensive behavioral treatments have made significant and enduring gains in language, IQ, communication, academic performance, adaptive behaviors and social behaviors. There are a number of other systematic reviews, that attribute varying degrees of effectiveness, to interventions based on the science of applied behavior analysis, for children with autism (Eikeseth, 2009; Eldevik, Hastings, Hughes, Jahr, Eikeseth & Cross, 2009; Howlin, Magiati & Charman, 2009; Reichow and Wolery, 2009; Rogers & Vismara, 2008).

Throughout the world there has been an increase in recognition by various govenments and insurance agencies on the utility of ABA based interventions for treatment of ASD. Evidence of this comes from 47 states in the USA (as of February 2016), which have laws mandating insurance cover, based on each states criteria (Sharpe & Baker, 2011), for diagnostic and treatment services to children with autism (Hendrix Reynolds, 2009). The Kennedy Krieger Institute of Maryland (USA) and Research Autism (UK) promote behavior analytic interventions; while the Ontario, Canada government covers costs for IBI interventions up to the age of three years for children with autism.

4.5 ABA and Verbal Behavior

The importance of mediation in the development of verbal behavior (Skinner, 1957) with specific reference to mand training cannot be overemphasized. The manipulation of environmental variables as per the four-term contingency to evoke vocalizations has been studied in depth in the behavior analytic literature and published in various peer reviewed journals such as Journal of Applied Behavior Analysis (JABA), The Analysis of Verbal Behavior (TAVB), The Journal of Experimental Analysis of Behavior (JEAB), and Research in Development Disabilities (RIDD). However some studies have concluded that the empirical evidence provided in literature is limited (McPherson, Bonem, Green, & Osborne, 1984) as most publications focus on mands and tacts; this was corroborated by a review of studies between 1963-2004 by Sautter and LeBlanc (2006) suggesting a three-fold increase in publications with a total of 60 studies, of which 43 focused on the mand repertoire. It has been suggested that mands facilitate the development of tacts and other verbal operants (Arntzen & Almas, 2002; Braam & Sundberg, 1991; Drash, High & Tudor, 1999); and contriving establishing operations to teach children with autism, establishes functional mands (Bowman, Fisher, Thompson, & Piazza, 1997; Sundberg, Loeb, Hale, & Eigenheer, 2002). Using ABA principles like prompting, prompt fading, differential reinforcement in conjunction with manipulation of establishing operations improves verbal behavior in children with autism (Sundberg et al., 2002) and a failure to acquire advance verbal behavior like asking questions, if establishing operations are not incorporated in the teaching.

4.6 Summary

The current chapter clearly establishes the importance of behavior analytic intervention in skill acquisition. The next chapter reviews in detail motivating operations, their powerful role in mand training and evocation of first instances of speech in non-vocal children with autism and other developmental disabilities. Motivating operations constitute a separate principle of behavior with several characteristics separated from reinforcement, stimulus control and schedules of reinforcement and can be manipulated as an independent variable for the emergence of human language (Sundberg, 2013).

Chapter 5: Motivation and Motivating Operations

5.1 Introduction

Motivation and what makes people behave in specific ways is of paramount interest to the field of psychology in general, and behavior analysis in particular (Buss, 1995; Carter & Seifertm 2013; Miguel, 2013, Sundberg, 2013; Weiner, 1972). In this chapter, motivation and the effects of independent antecedent variables that establish or abolish motivation and their effects on subsequent behavior are delineated.

Motivation is a key factor in understanding behavior. Teachers motivate their students, the legal system identifies motives for unsocial acts, parents motivate their children to do well, and advertisements motivate the buyer to buy their products. Yet, often motivation has been considered a hypothetical construct explained as something intrinsic, e.g., a student, who does not practice the piano regularly was simply thought of as not being motivated to practice. Some learning theorists saw this in terms of internal states or “drive”, e.g., Hull (1943) suggested a “drive” to be a physiological event, which prompted an action.

In contrast, Skinner (1938; 1957) viewed “drive” as related to environmental variables of deprivation, satiation and aversive stimulation. He explained that, ‘hunger’ is a hypothetical state and depends on satiation and deprivation. The evocative effect of satiation or deprivation on behavior is considered observable and measureable and applied to all behaviors except involuntary behaviors, which are mainly reflex responses. The relation of satiation and deprivation on response strength was studied by Keller and Schoenfeld (1950) in their experiments on rats. They found the rate of bar presses varied depending on states of satiation and deprivation and coined the term “establishing operation” (p. 273) to describe the independent variable and considered the resultant degree of behavior change the dependent variable. They described, “drive” as certain environmental “operations” which have an effect on behavior. Skinner (1953) did not use the term establishing operation, however, he discussed the functional relation between levels of satiation, deprivation and aversive stimulation and their evocative effects on behavior.

Holland and Skinner (1961) further suggested that motivation involves a functional relationship between the momentary value of events, which function as reinforcers or punishers, and the frequency of behaviors, which at a prior point in time had been reinforced or punished. Furthermore, the emission of a response could be explained by motivational variables and previous conditioning histories (Millenson, 1967).

Michael (1982, 1988, 1993, 2000) expounded Skinner's analysis on the concept of motivation and adopted the term "establishing operation", coined by Keller and Schoenfeld (1950), and defined it in terms of its value altering and behavior altering effects of the motivating variables (Michael, 2003).

5.2 Establishing operation

Establishing operation has been defined as "An environmental event that affects an organism by momentarily altering or changing (a) the reinforcing effectiveness (value) of an object stimulus or event (b) that results in the change in frequency of occurrence of the behavior of the organisms repertoire relevant to those events as consequences" (Michael, 1993, p.192). For example, the momentary value of food as a reinforcer increases when an organism is deprived of food and increases the frequency of a class of behaviors, which have yielded food. Deprivation of food in a child (a) will make food a highly effective reinforcer and (b) have the child evoke a variety of behaviors based on a history of reinforcement such as, searching for food, pulling hand towards food, crying, signing food or saying "eat". Deprivation of food, increased the reinforcing effectiveness (value) of food as a reinforcer, and was termed "reinforcer establishing effect" while the effect of satiation was termed "reinforcer abolishing effect". With respect to behavior, food deprivation had an "evocative effect" while the operation of satiation had an "abative effect" on behavior (Michael, 2003).

The evocative effect on behavior was demonstrated in an underwater experiment in a Y maze with rats where the longer the rat was deprived of air its efficiency on acquisition tasks increased (Broadhurst, 1957). Establishing operation increases the value of the reinforcers (Michael, 1993). These changes last as long as the motivating variable was in effect and in this sense were momentary in nature, as contrasted with the changes produced by respondent or operant conditioning or extinction or by the type of pairing that cause stimuli to become conditioned reinforcers or punishers (Michael, 1988).

5.3 Motivating Operation

The term motivating operation (MO) has been used by Laraway, Snycerski, Michael and Poling (2003) as an omnibus term for establishing operation (EO) and abolishing operation (AO) in which case the MO's value altering effect is an a) EO when it increases the reinforcing effectiveness of a stimulus and b) AO when it decreases the reinforcing effectiveness. The behavior altering effect of the motivating operation has an a) evocative effect, when it increases the immediate frequency of behavior or b) an abative effect, when it decreases the immediate frequency of behavior that has been reinforced in the past. The omnibus term motivating operation or its acronym (MO) will be used throughout this study.

5.4 Motivating Operation and the Discriminative Stimuli

Behaviors controlled by motivating operations (MO) are different from those under the control of discriminative stimuli (S^D) although both are antecedent stimuli directly controlling (i.e. evoking) behavior. The evocative effect of the MO may sometimes be confused with the (S^D). For example, a dry or parched mouth could be a discriminative stimulus (S^D) for the behavior of asking for water while deprivation of water creates the MO for the same class of behaviors (i.e. searching, asking, getting, buying water). In order to use MO as an independent variable it is critical to differentiate between an S^D and MO.

This distinction between the MO and S^D, was elaborated by Michael (1982). Availability of reinforcement in the presence of particular stimulus provides discriminative properties to stimulus, which is termed discriminative stimulus (S^D). An S^D evokes behavior as it has been correlated with the availability of reinforcement in the past due to the temporary pairing between the response-reinforcer contingencies, e.g., the arrival of a customer at a retail shop evokes a greeting from Mr. X. The customer here is the S^D for evoking a greeting from Mr. X, whose behavior has access, generalized reinforcers in the past from supervisors. However on a particular day due to sickness or an argument at home, the MO has an abative effect on his behavior and the greeting exchange might not occur despite the availability of the consequences. A mand is an excellent example highlighting the difference between an MO and S^D, as the mand occurs under conditions of deprivation in contrast to other verbal operants such as tacts and intraverbals (Sundberg, 2013).

5.5 Unconditioned and Conditioned Motivating Operations

The manipulation of motivating operations, plays a critical role in the evocation of mands. Michael, (1993) suggested two types of motivating operations the unconditioned establishing operation (UEO) and conditioned establishing operation (CEO). The UEOs are forms of motivation that require no learning histories, i.e., which occur due to deprivation of events like sleep, water, temperature change, or oxygen deprivation. The UEOs reinforcer establishing effect is innate however the behavior evoked by the UEO is learned. A person deprived of water may find "water" a highly effective reinforcer due to innate causes, however may behave in different ways in his search for water where the searching behavior will depend on learning histories. Conditioned motivating operations (CMO) on the other hand, involve learned forms of value altering and behavior altering effects (Michael, 2007) and are of three types: reflexive (CMO-R), transitive (CMO-T) and surrogate (CMO-S) (McGill, 1999; Olson, Laraway & Austin, 2001).

The CMO-R is a warning stimulus for a worsening set of conditions, i.e., they precede an aversive event, thus making escape or avoidance highly reinforcing. For example, the teacher randomly calling student's names before asking questions may act as a warning stimulus and, if an appropriate response is not made, a socially worse situation may occur. Innumerable human behaviors are under the functional control of aversive stimulation such as the glare of sun, the ringing of the alarm clock, or rush hour traffic, which are everyday aversive stimuli that are usually preceded by CMO-Rs, such as hot weather, ringing of the clock, or the traffic news, affect behaviors, such as wearing sunglasses, switching off the alarm clock, pressing the accelerator to speed up the car. CMO-Rs also have applications for teaching socially significant behaviors, such as language acquisition and adaptive skills (Carbone, Morgenstern, Zecchin-Terri. & Kolberg, 2007; Langthorne & McGill, 2009, Sundberg, 2013). For example presentation of high rate of instructions by a conscientious therapist offering very little positive reinforcement for a child during an intensive IBI session may correlate with a worsening set of conditions and evoke previously reinforced behaviors like screaming to avoid or terminate the teaching session (McGill, 1999; Michael, 2000) leading to removal of task demands. In this case the therapist's arrival, teaching materials and voice begin to function as CMO-R.

Transitive conditioned motivating operations (CMO-T) are not dependent on direct effects of deprivation. The transitive CMO consists of a stimulus condition that makes another stimulus condition effective as a form of conditioned reinforcement and establishes the effectiveness of another event as a reinforcer or punisher. For example, the presentation of a paper and being asked to "write a phone number" results in asking/searching for a "pen". Only when asked to write something (CMO-T), and being handed a paper (S^D), the search for the "pen" (S^D) begins and "pen" becomes valuable. The condition of CMO-T thus provides ample opportunities for teaching mands to children with developmental disabilities (Hall & Sundberg, 1987; Lechago, Carr, Grow, Love, & Almason, 2010).

A surrogate CMO (CMO-S) can be elucidated as; a previously neutral stimulus that, due to a temporal association with a UMO or other CMO, independently alters the effectiveness of other stimuli as reinforcers or punishers and alters the probability of associated behaviors (Langthorne & McGill, 2009). For instance, the state of food deprivation gets paired with a clock showing 12 noon, repeatedly for a person who has his meal at mid day. After repeated pairings the time on the clock at 12 noon could create condition of motivating operations making food more valuable as a reinforcer and also cause an increase in behaviors that involve seeking food. Another example, the sight of an empty chocolate wrapper being repeatedly paired with a state of satiation. The empty wrapper, a neutral stimulus, could acquire an influence which serves to abolish the value of chocolate as a reinforcer regardless of the actual level of deprivation or satiation. It could also cause some reduction in current frequency of behaviors that involve accessing chocolate. It is possible to extend these to pairing of neutral stimuli with other types of motivating operations such as a decrease in temperature, increase in painful stimulation etc.

5.6 Motivating Operations and Verbal Behavior

Motivating operations as an independent variable can thus be manipulated and plays an important role in language acquisition (Betz, Higbee & Pollard, 2010; Endicott & Higbee, 2007; Skinner, 1957; Sundberg, 1993; Sundberg & Michael, 2001; Sundberg & Partington, 1998). Lee, Luke and Lee-Park (2014) in their experiment with 2 infants controlled the MO (edible) by creating a state of deprivation by delaying the presentation of food while it was available. The adults looked and smiled at the infants in baseline, mand training and DRO conditions. During baseline, vocalizations by the infant were ignored; during mand training vocalizations were followed by delivery of one spoon of baby food while in DRO food was delivered after 5 seconds of silence. Results suggest vocalizations increased to high levels under mand training conditions while remaining low during baseline and DRO.

A mand is a verbal operant evoked by the motivating operation. Scattone and Billhofer (2008) conducted a preference assessment to identify target items preferred by an 8 year-old non-vocal child with autism. Mand training was conducted when the child reached out for preferred items and the dependent variable was using sign for mands, tacts and intraverbal. Results suggested signs were acquired during mands in fewer sessions than during tact training proving MO is a variable in mand acquisition. Almost 85-90% of children with autism below 5 years-of-age acquired verbal communication when motivational techniques were incorporated in their intervention programs (Koegel, 1995; McGee, Daly, & Jacobs, 1994).

A number of empirical studies have focused on the role of motivating operations in the replacement and reduction of problem behavior (McGill, 1999; Smith & Iwata, 1997; Wilder & Carr, 1998) where functional communication training or teaching to mand for the removal of an aversive stimulus was taught. For example, an aversive condition (UMO) created by a full bladder may lead to teaching the mand “may I go to the toilet please?” resulting in the consequence of being allowed to go to the toilet, an empty bladder, and a feeling of comfort.

5.7 Contriving MOs

Mands are controlled by motivating operations; and therefore, when teaching a child to mand an MO needs to be in effect. If a child does not want a cookie, the mand for cookie cannot be taught at that time and an MO has to be contrived to teach language acquisition. Contriving situations to control environmental variables like satiation, deprivation and aversive stimulation can evoke verbal behavior. This means that, while conducting mand training, the environment is manipulated in ways that certain outcomes can become valuable. For example, the value of a “straw” can be increased when the child wants juice (MO) by giving a tetra pack of juice without the straw creating a condition for teaching the child to ask for “straw” so that the juice can be consumed. Other examples of contriving MO include giving the child a small bite of chocolate to teach the child to say “more”; giving the child paint for painting without a brush; providing access to a video but putting on the news.

Contriving MO may be done by withholding reinforcers prior to mand training, limiting teaching trials by avoiding satiation, providing limited access to reinforcers followed by blocking access, or teaching mands for missing items (Albert, Carbone, Murray, Hagerty, & Sweeny-Kerwin, 2012, Hall & Sundberg, 1987). In their study on a 4 year old boy with autism Davis, Kahng, and Koryat (2012) identified one high preference and another low preference stimuli which were taught as tacts while probes were conducted for the same stimuli as mands under conditions of satiation (pre-session access to both stimuli for 2-25 minutes) and deprivation (no access to stimuli for 2-3 days). Results suggested the boy began to mand for both high and low preference items under conditions of deprivation, although mands for low preference items gradually decreased. This demonstrates the importance of manipulating MO by limiting access to reinforcers and its evocative effect on mands.

Verbal behavior training often occurs with items present and visible. Manding however was not always dependent on discriminative stimuli such as the presence of the item or someone asking, “What do you want”. Sundberg, Loeb, Hale, and Eigenheer (2002), taught children with autism to mand for information using “Where (item?),” by contriving an MO for the location of a missing item. This was taught by initially, giving access to a preferred item in a container, and later giving the container without the item. Once the successful acquisition of this mand was acquired, the establishing operation was further contrived for the mand "who" for a specific person. The experiment suggests that by manipulating the establishing operation as an independent variable, mands for information can be evoked. Hartman and Klatt (2005) studied the effects of deprivation levels of 23 hours and 5-min pre-session exposures and compared it with manding for high and low preference toys kept out of view. The experiments were conducted on two 2.5-year-old boys with autism. Results suggested that deprivation of 23 hours led to an improved rate of manding for both high and low preferred toys in one participant while the second participant manded for highly preferred toys only under deprived condition (23 hours) and the 5-min pre-session exposure condition. The study highlighted that given the deficits in acquisition of verbal behavior in children with autism, during mand training, establishing operation and individual preferences both need to be considered. At the same time selecting highly preferred items for which a child has been deprived may lead to higher rates of acquisition.

5.8 Summary

Motivating operations are thus an important independent variable for building language repertoires. They have value-altering, as well as behavior-altering effects and can be manipulated to build a verbal repertoire in an individual. Behavior analytic research provides enough evidence on the role motivating operations play in evoking language, especially mands in vocal and non-vocal children with autism. Initial steps in the identification of the establishing operation requires a detailed preference assessment as communication training in non-vocal children with autism begins with identifying high preference stimuli. The next chapter discusses stimulus preference assessment in detail.

Chapter 6: Stimulus Preference Assessment

6.1 Introduction

Mand training interventions begin with the identification of items, activities and events highly preferred by an individual and requires establishing a hierarchy of preferences. Preference may be defined as the relative strength of behaviors when two or more choice options are presented (Catania, 1998; Pear, 2001) and is often measured by the patterns of selection (Martin, Yu, Martin, & Fazzio, 2006).

Individuals with autism are often unable to express their preferences due to lack of speech, or an ability to make a choice between multiple discriminative stimuli. For example tangibles may be discriminative stimuli (S^Ds) for choice making, however being asked "do you want cookie or ball" may not be easy to choose from (Conyers, Dooley, Vause, Harapiak, Yu, & Martin, 2002; de Vries, Yu, Sako, Wirth, Walters, Marion, & Martin, 2005; Schwartzman, Yu, & Martin, 2003) for a child with autism. For a typical child verbally responding to their choice and the degree of preference are sufficient however for a child with autism it may require making multiple responses towards a variety of stimuli to indicate strong or weak preferences.

Stimulus preference assessments are used to identify stimuli that are likely to serve as reinforcers or with respect to this research, in the selection of mands. A stimulus that increases the future frequency of behavior that immediately precedes it is called a reinforcer. Preferences of an individual shift over time sometimes even several times within a week or day. The magnitude of preference also varies across stimuli and can be verified using proxies such as duration of engagement. For example an individual may be reading a book for several hours but may switch the television off after a cursory check. Since operant conditioning procedures rely on stimuli that can exert a powerful strengthening effect on behavior it is important to identify stimuli that are likely to be effective as reinforcers. Preferred stimuli sometimes do not function as reinforcers (i.e., strengthen the behavior they reliably follow); preferences also change with age, time of the day, social interaction with peers and presence of motivating operations (conditions of satiation, deprivation or aversive stimuli). In the context of mand training this becomes even more important as a mand specifies its own consequence.

Prior to conducting a preference assessment it is necessary to distinguish between a stimulus preference assessment and reinforcer assessment. While the stimulus preference assessment serves to identify stimuli that can serve as reinforcers, reinforcer assessment puts potential reinforcers to direct test by presenting them contingent on occurrences of behavior and measuring any increasing effects on response rates. A discussion on the latter would not be within the scope of this chapter.

6.2 Procedures used in Stimulus Preference Assessments

Preference assessment refers to a collection of procedures that could be used to identify stimulus preference and assessment procedures range from very simple interviews to complex and time-consuming procedures.

Interview Based	Free Operant	Trial Based
Asking Person	Contrived Observation	Single Stimulus
Significant Others	Naturalist Observation	Paired Stimuli
Pre-task Choice		Multiple Stimuli

6.2.1 Interviewing Significant Others

One method of identifying preferences is through interviews using open-ended questions or providing a list of choices and asking guardian of the child with autism, to rank choices from most to least preferred. Open-ended questions such as “tell me what does your child engage in during leisure time?” “what type of music does he/she listen to?” or “name some favourite food and drinks”. Interviewing or asking open ended questions to the child themselves is also an option.

A long list of potential reinforcers can be prepared by asking parents, significant others, caregivers, teachers or friends. Fischer et al. (1996) used an interview protocol called the RAISD (Reinforcer Assessment for Individuals with Severe Disabilities). The tool included a list of stimuli across visual, auditory, olfactory, edible, tactile and social domains. Significant others ranked the selected stimuli based on high versus low preferences. In addition they were also asked to identify the conditions under which a stimulus could function as a reinforcer. For instance whether a hand held gadget functioned as a reinforcer only at particular instances, such as when the learner returned from school or at any other time of the day.

Although asking about preferences is easier to implement, it suffers from the limitation that a self-reported preference may not serve as a reinforcer (Northup, 2000, p.335). Further, children with autism and other learning disabilities may not have responding to questions in their repertoire and personal nomination (Clements & McGee, 1968) and reinforcer surveys (Fox & DeShaw, 1993) may be limited by insufficient verbal skills (Pace, Ivancic, Edwards, Iwata, & Page, 1985; Rotatori, Fox, & Switzky, 1979).

6.2.2 Pre-Task Choice

Offering pre-task choice is another method, which involves asking the learner to choose from a set of options the item or activity he would like to work for. A person can also be asked to rank stimuli, events or activities in order of preference. During ordering by rank a participant is given a list of items or activities and asked to rank them from most to least preferred. For learners with limited language abilities, supplementary stimuli such as pictures of the items or activities can be presented with the learner nodding yes or no to indicate choice.

A comparison of caregiver opinions on client preferences with results from systematic stimulus preference assessments (Green et al., 1988) was made on seven profoundly retarded and non-ambulatory individuals in a residential facility attending school. Twelve stimuli were chosen and each student was presented each stimulus 36 times over a 5-week period. Approach or avoidance behavior was recorded for each trial. In addition, 35 staff members rated each stimulus, for their students on a scale of 1-5 (least to most preferred). The study found no correlation between staff opinion rankings and the rankings produced by systematic assessments. However, for each student there was at least one stimulus that was highly ranked on both systematic and staff assessments. Results also indicated that at least one of the stimulus ranked high on systematic assessments was accompanied by behavior change for all 5 students who participated in this stage. They also found that stimuli that ranked low on systematic assessment (regardless of whether they ranked high or low on staff opinion) produced no behavior change. Further, not every stimulus systematically assessed as highly preferred functioned as a reinforcer. The authors concluded that additional research would be needed to increase the predictive validity of the systematic assessment method to identify reinforcing stimuli.

Observations based on direct preference assessments have been considered superior to identifying preferences based on asking or interviewing as very often significant others and caregivers as the primary source of information may be unable to predict choices and preferences (Green, Reid, White, Halford, Brittain, & Gardner, 1988; Windsor, Piche, & Locke, 1994) or not be as accurate as direct preference assessment procedures (Green, Reid, Canipe, Garner, 1991; Resetar & Noell, 2008).

6.3 Observation Based Direct Preference Assessment

There are five direct preference assessment procedures developed to assess preferences of individuals with autism and developmental disabilities. In these methods the child is presented a variety of items systematically and his/her choices are observed systematically. These are, free operant preference assessment (FOPA), single stimulus preference assessment (SSPA), paired-stimulus preference assessment (PWPA), multiple stimulus with or without replacement (MSW, MSWO).

6.3.1 Free Operant Preference Assessment (FOPA)

A free operant preference assessment involves observing and recording items and activities a person engages with when allowed unrestricted access for a period of time. This includes assembling a pool of items, which are within sight and reach, and made available to the child (Ringdahl, Vollmer, Marcus, & Roane, 1997). This is a duration-based assessment with neither response requirements nor restriction on duration of engagement. Further, no item is removed after engagement or selection. The main advantage of free operant observation is that it accommodates larger pools of items and activities, and reduces levels of inappropriate behaviors (Karsten, Carr, & Lepper, 2011; Ortiz & Carr, 2000,), which may emerge when the effort required to indicate choice is high; when items are withheld to evoke some form of communication, or preferred stimuli are removed after selection. Free operant preference assessment requires the observer to make adequate time for observation. Typically, the duration of engagement with one item, relative to another, reflects the strength of preference (Worsdell, Iwata, & Wallace, 2002). Free operant observations can be conducted in contrived as well as naturalistic settings.

6.3.1.1 Contrived free operant observation

This method of observation is contrived because the assessor "salts" or makes available a set of pre-determined items/ activities or stimuli in the environment of the learner. Prior to the observation period, the learner is provided brief non-contingent exposure to each item. The learner is also provided sufficient time to explore the environment. A variety of items like toys, piano, iPad, balloons, blocks, puzzles, doll, animals, etc. (Preference Assessment list T10, Appendix) within sight and reach of the person are made available freely and duration spent interacting with each item reflects preference strength.

6.3.1.2 Naturalistic free operant observation

In this method, an observer notes the duration of engagement with various items or activities in a natural environment setting such as the learners home with his preferred items like the television, iPad, books, etc. Engagement in a natural environment like a park with play equipment such as swings, slide, trampoline, merry-go-round, see-saw which are fixed can be observed as the child accesses them. During observation the frequency at which an item is accessed and the duration for which the child engaged with the play item or activity is noted.

Sautter, LeBlanc and Gillett (2008), in their study with six children with autism and their siblings used a free operant preference assessment to select toys for free play between siblings. Selected toys belonged to two categories, sensory toys and developmental toys, which were evaluated based on type of play, problem behavior, social initiations and responses to social initiations. Six toys identified by the caregivers were equally spaced around the room in a circle on the floor. The child was led to the center of the circle and briefly exposed to the features and instructed to play.

The researcher recorded duration of play with each toy. After 5 minutes the child was taken away and toys were exchanged. The percentage duration of toy engagement was calculated by dividing duration of engagement with each toy with total duration of access multiplied by 100. Based on the preference gradient four toys were identified; a high preference and a low preference developmental toy and one each of high and low preference stimulating toy. Based on the above detailed preference assessment conducted in phase 1 of the study, the selected toys were included in phase 2 where they were placed in pairs in a room and each dyad of child with autism and his sibling were led to the room with an instruction to the siblings to play. An analysis of play suggested 50% more engagement with high preference stimulating toys in all dyads and 50% and more engagement with developmental toys in only two dyads. Engagement with toys was observed as 77% & 8% with high and low preference stimulatory toys respectively and 47% and 14% with high and low preference developmental toys. Five of the six participants engaged in 83% interactive play in at least one play session. The authors concluded free operant preference assessments were highly effective in identifying toys that produced fun and play among sibling dyads in a non-demanding setting. This study demonstrates free operant preference assessment can be used to identify preferences other than reinforcers. FOPA is a duration based preference assessment

6.4 Trial Based methods

6.4.1 Single Stimulus Presentation (SSPA)

Single stimulus presentation (SSPA) involves presenting one stimulus at a time in random order and recording the duration of engagement with each to determine preference (DeLeon, Iwata, Conners, & Wallace, 1999; Green et al., 1988; Pace, Ivancic, Edwards, Iwata, & Page, 1985), observing the frequency of responses such as touches per minute or occurance of approach or rejection responses in the form of yes or no. This method was used with individuals who had difficulty selecting from two or more stimuli. Using this method multiple preferred items could be identified and a larger selection of items and activities accommodated. With single stimulus presentation, position bias is also eliminated. However, one of the limitations of the method is that it could lead to identification of false-positive preferences except when duration of engagement is measured (Karsten et al., 2011). Another limitation of the single stimulus method was selection of each stimulus presented (Fisher et al., 1992; Mazaleski, Iwata, Vollmer, Zarcone, & Smith, 1993) occuring due to lack of choice making and the acceptance of each stimulus presented.

6.4.2 Paired Stimulus Presentation (PSPA)

Paired Stimulus Presentation (PSPA) is also known as the “forced choice” method. In this method, the assessor presents two stimuli simultaneously on each trial and asks target person to choose one. Each stimulus is matched with every other stimulus in the set of all possible pairings. For instance, if there is a car, block and iPad present, the car will be presented with block in trial 1, and presented with iPad in trial 2, and block with iPad in trial 3. These may be repeated several times and the percent of trials each stimulus was chosen over another can be used to rank the preferences (Datillo, 1986; Fisher, Piazza, Bowman, Hagopian, Owens, & Slevin, 1992).

Piazza, Fisher, Hagopian, Bowman and Toole (1996) studied the effectiveness of reinforcers using a paired stimulus presentation. Four participants between 7 to 19 years with destructive behaviors underwent a PSPA. Stimuli were placed 0.7 m apart, and approach towards a stimuli led to 5 second access to it while the other stimulus was removed. Simultaneous approach to both was blocked while no approach led to re-presentations for an additional 5 seconds. Stimuli were divided into three categories high preference (ranked 1,2,3) medium (ranked closest to median) and low (last three) based on frequency of selection. Three pre-selected responses were paired with the three categories of stimuli during training. For example sitting on chair A resulted in access to high preference stimuli, chair B produced low value and chair C resulted in extinction. Results suggested behaviors, which accessed high preference stimuli, increased proving high preference items consistently functioned as reinforcers for all four participants while low preference stimuli did not function as reinforcers for any client.

Fisher et al. (1992) compared the single stimulus preference assessment (Pace et al., 1985) with the paired choice assessment and demonstrated the superiority of the latter, as it differentiated among stimuli to identify reliable reinforcers. It further revealed the PSPA method ranked stimuli as high or low preference thereby finding them more effective (Paclawskyj & Vollmer, 1995) as reinforcers in visually impaired students.

Karsten et al. (2011) suggest this method can help identify multiple preferred items, and accommodates larger and a greater number of table top items however requires more time (DeLeon & Iwata, 1996) than the MSWO and FOPA and might be influenced by positional bias. Ciccone, Graff and Ahern (2015) suggested that the efficiency of PSPA can be increased by identifying categories of preferences (e.g. salty, crunchy, fruit) to allow clinicians to select untested stimuli from those ranked as highly preferred from the same category.

6.4.3 Multiple Stimuli Presentation Without Replacement (MSWO)

The multiple stimuli presentation is an extension of paired stimuli presentation procedure. It involves presentation of a linear array of 3 or more stimuli. The stimuli presented in each trial may be tangible objects or pictures of items (DeLeon & Iwata, 1996). Each trial starts with asking the person “which one do you want most?” The participant is provided 10-s access before the stimulus is removed from the array and the presentation is repeated till the last two items are presented. Selection of stimuli is followed by rearranging the remaining stimuli in a quasi-random manner. Any attempt to select more than one item is blocked. The same stimuli are presented again. The order in which the items are selected reflects preference and its ranking. The entire sequence is repeated several times. This method can identify multiple preferred items in minimal time however it requires more time than FOPA and is limited to items, which can be presented at tabletop. At times positional bias may influence the assessment (Karsten et al., 2011).

6.4.4 Multiple Stimuli With Replacement (MSW)

The multiple stimuli with replacement (MSW) is based on procedures described by Windsor, Piche, and Locke (1994). It involves presenting an array of six items (food and leisure items) placed approximately 7 cm apart and presented on the table in a straight line. The instructor asks the participant to “pick one” item from the array. The selection of an item results in the removal of all items in the array. The participant is allowed to consume the edible or play with the leisure item for 30 seconds. Attempts to select more than one item are blocked. Following each trial all items are placed back on the table and moved one place to the left to avoid position bias. Non-selection within 30 seconds leads to termination of the trial and scored as a “no response”.

Kodak, Fisher, Kelly, and Kisamore (2009) alternated the FOPA and the MSW comparing the highest preferred items selected from both methods for four children with autism. Pictures of highest preferred items identified from both methods were placed on the table. A selection was followed by providing access to the preferred stimuli (mand) for 30 seconds. Results suggest all participants identified different items as most preferred. Reinforcer assessment indicated MSW identified the most effective reinforcers for two participants, thus concluding that preferences may vary across different procedures and length of access could be a variable influencing selection (e.g. candy vs playing a video game).

6.5 Summary

There is enough evidence from research, that for people with developmental disabilities and autism, direct preference assessment is the most effective approach for identifying preferences (Tullis, Cannella-Malone, Basbigill, Yeager, Fleming, Payne, & Pai-Fang, 2011) as compared to preferences identified by caregivers (Kenzer & Bishop, 2011). When time is a constraint selection based preference assessments are more efficient than engagement based. MSWO is more efficient than PSPA when a larger array of stimuli needs to be assessed and while they produce similar results in identifying preferred stimuli the MSWO format requires less time than the PSPA with a mean of 22 min vs. 53 min (DeLeon & Iwata, 1996) respectively. SSPA also shows a direct relation between the number of stimuli and time taken. The amount of time spent interacting with stimuli relative to another reflects the strength of the preference (Worsdell, Iwata, & Wallace, 2002). For occasions when duration of engagement needs to be assessed such as in the case of engagement with leisure items and items available in the natural environment, the FOPA may be a more valid approach while MSWO and PSPA can effectively identify preference hierarchies and may be effective for preference assessment with edibles and toys presented at the tabletop (Virues-Ortega, Pritchard, Grant, North, Hurtado-Parrado, Lee, temple, Julio & Yu, 2014). Stimulus preference assessments based on presentation of tangible objects produce greater variation and distribution of preferences as opposed to pictures (Higbee, Carr & Harrison, 1999).

The current study used FOPA in the park area with play equipment, the MSWO at the tabletop with a wide range of stimuli, and the SSPA when identifying songs and rhymes on the computer.

The next chapter reviews the literature in detail on varied interventions for evoking vocalizations and improving communication in children with autism.

Chapter 7: Interventions To Facilitate Vocalization

7.1 Introduction

Most children with autism fail to develop speech on their own (Rutter, 1978) and have to be trained using specific teaching models to develop speech. Many will acquire speech only when intervention is provided (Rutter, 1985); however even with intervention, nearly 50% of children diagnosed with autism will remain functionally mute and non-verbal well into adulthood (Peeters & Gillberg, 1999; Prizant, 1983). Koegel, Shirotava and Koegel (2009) proposed that 10-25% of children with autism failed to develop speech despite progress in techniques for improving verbal (vocal) communication. The range of speech abilities in persons on the autism spectrum can vary considerably from non-vocal (using no syllables, phonemes or words), to those with an ability to produce speech sounds without communicative intent (example babbling, humming rhymes, vocal stereotypy), or having the ability to produce single words but intelligible only to familiar people due to speech errors, or having fluent phrase speech across some specific verbal operants.

7.2 Interventions And Effect on Vocalization

Key studies that have addressed the issue of increasing vocalizations in children with autism and the methods or technologies for increasing or inducing vocalizations fall under the following broad classes:

A. Echoic training with shaping,
B. Reinforcing any/all vocalizations made by non-vocal children,
C. Milieu language teaching,
D. Using individual orienting cues,
E. Antecedent rapid motor imitative sequence (RMIA),
F. Stimulus-stimulus pairing (SSP),
G. Alternative augmentative communication (AAC),
    i) Picture exchange communication system (PECS)
    ii) Manual sign training
    iii) Speech generating devices
H. Video-based mand training,

I. Intraverbal training

Research on each of the above interventions identifies the independent variables that can be manipulated to produce an effective technology to induce and increase vocalizations in children with low vocal verbal repertoire.

A. Echoic Training with Shaping

Teaching communication and verbal behavior requires the fundamental repertoire of echoing (Lovaas, 2003; Sundberg and Partington, 1998). Evoking vocals in non-vocal children with autism, having no speech and lacking the ability to imitate, is one of the most challenging tasks (Koegel, O'Dell, & Dunlap, 1988). Imitation of a vocal model has been the first step towards teaching verbal behavior based on the assumption that speech is acquired by imitating an adult model. Early language training in behavioral science originated with vocal imitation as it provided pre-requisites for teaching other operants (Sundberg, 1990). Interventions incorporated vocal imitation training (i.e. echoic training) as an initial step in language training programs (Drash & Leibowitz, 1973; Guess, Sailor, & Baer, 1976; Lovaas, Berberich, Perloff, & Schaeffer, 1966; Lovaas, 1977), which included reinforcing successive approximations to the instructor's vocal models.

Lovaas et al. (1966) conducted the first published systematic study that addressed teaching speech to persons who had never spoken. Two 6 year-old children diagnosed with schizophrenia (NB; it is possible that children diagnosed with ASD today would have been diagnosed with schizophrenia in the 1960s) who never spoke and managed some vowel sound productions occasionally but without any context or communicative intent were participants in the study. They also demonstrated other core symptoms of autism such as lack of appropriate toy play, self-stimulatory behaviors such as rocking and twirling, lack of initiation of social contacts and occasional self-injurious behaviors. To bring vocalization under imitative control Lovaas et al. implemented a 4-stage procedure. In the first stage, reinforcement was delivered contingent upon the participants producing a vocal within a specified time after an adult emitted a vocal model. In the second stage, vocals emitted were reinforced only if they resembled adult vocals. In the third stage, such vocals were reinforced only if the resemblance to adult's model was very close. Prompts and prompt fading were used in the third stage such as holding the child's lips closed and releasing while training the sound 'b'. To ensure discrimination in Step 4, a new sound was introduced and randomly interspersed with the sounds of Step 3. The training intensity was quite high at 7 hours per day with 15 minutes breaks each hour. As the training sessions were an hour long with 15 minute breaks 7 hours a day and the children were from a vulnerable population, such procedures would not pass the ethical muster and hence do not lend themselves to replication today. The authors state that problem behaviors that interfered with learning were suppressed within one week. The results as such should be judged with considerable caution. While the first word took several days to be acquired, by the 26th day both children acquired several words. Responding however deteriorated when reinforcement was shifted to an interval-based schedule as opposed to response-based schedule wherein reinforcement followed correct imitative behavior and withholding reinforcement followed incorrect responding.

Behavioral studies on echoic training thereafter have focused more on improving articulation (Eikeseth & Nesset, 2003) or increasing complexity of echoics (Tarbox, Madrid, Aguilar, Jacobo, & Schiff, 2009) rather than increasing vocalizations. Tarbox et al. (2009) increased the complexity of echoics in three children using a chaining procedure. The participants were between the ages of 3-7 years with a diagnosis of autism. All three participants used single syllable utterances during communication. The independent variable of chaining consisted of breaking each target echoic into two components (e.g. Monday was divided in "mun" and "day") and having the child echo each component after the model. The results suggested the chaining procedure could be effective in increasing the complexity of the echoic utterance.

Kodak and Clements (2009) demonstrated that when echoic training was conducted concurrently with mand and tact training in a child with autism lacking functional vocal-verbal behavior and engagement in high level of stereotypy, it facilitated acquisition of mands and tacts as compared to mand-only and tact-only training. In another study, three children between the ages of 2.6 years and 3.6 years participated (Drash, High, & Tudor, 1999). All three children imitated a few single syllable sounds at 40%, 25%, and 54% accuracy. Drash et al. argued that using the mand as a starting point to shape and establish an echoic repertoire is highly effective in severely language-delayed children. They first established a mand repertoire by keeping preferred items out of reach and providing verbal prompts under conditions of establishing operations and reinforcing any vocalizations other than crying, yelling or screaming. Subsequently reinforcers were provided for specific rather than any vocalizations. These were used to shape an echoic repertoire. The echoic was further strengthened by presenting novel stimuli which were not used for manding e.g. saying ‘this is a fish. Say fish’. The echoic repertoire was later used to shape a tact response by asking, “What is this?” and prompting. The results suggest all three children acquired responses to 90% mand repertoires by the sixth session and echoic repertoires with 70% accuracy by the seventh session.

There have been mixed outcomes with echoic teaching procedures. Despite some success in initial studies (Baer, Peterson, & Sherman, 1967; Brigham & Sherman, 1968; Lovaas et al., 1966) and theoretical appeal it was unclear why echoic training was ineffective (Stock, Schulze, & Mirenda, 2008) with children with autism. Anecdotally, “happiness indicators”, such as laughing and smiling, increased during teaching conditions with access to preferred edibles as contrasted with the standard echoic training, which required an initial imitative response. Standard echoic condition also appeared to act as a conditioned aversive stimulus resulting in escape-motivated behavior (e.g. running away from the experimenter) as in the case of one child (Stock et al., 2008). Research in echoic training so far is limited to participants who emit vocalizations except for two studies (Lovaas et al., 1966; 1973) with mute non-vocal children.

B. Reinforcing all vocalizations with a communicative intent

In the early stages of vocalization it may be counterproductive to withhold reinforcement for vocalizations that do not meet the requirement established by shaping procedures that mandate closer and closer approximations to adult models. Koegel, O’ Dell, and Dunlap (1998) looked at reinforcing all and any vocalization with a communicative intent, even if it did not resemble any part of the adult vocal model, in comparison to a procedure, where only successive approximations were reinforced. They used several reversals between the two conditions across four participants aged 3, 8, 9, and 11 years, all functioning at a non-verbal level (NB: the terms non-vocal or non-verbal has been used in the literature review as in the original study). Three of the children had formal diagnosis of autism and the fourth was diagnosed as developmentally delayed with autistic characteristics. The researchers measured the affect (with scores for happiness, enthusiasm, interest and general behavior) of participants during intervention, and improvement in speech production, under two conditions. In the 'motor speech' condition only successive approximations to adult vocals were reinforced and in the 'verbal attempts' condition all vocalization attempts with a communicative intent were reinforced. Results suggest that in the 'verbal attempts' condition their affect was in the positive range (measured by scores for happiness, enthusiasm, interest and general behavior), while they were in neutral to negative range in the 'motor speech' condition. Further, all the participants also showed greatest improvements in speech (measured by gains and losses within session based on phonemic criteria) in the 'verbal attempts' condition and less significant improvements or deterioration in the 'motor speech' condition. A follow-up revealed, that two children who had received the 'verbal attempts' treatment for 4 years spoke a total of 122 and 75 words with a range in length of utterance of 1-4 words and 1-3 words respectively. One child who had received 4 years of 'motor speech treatment' did not utter any words in the follow-up phase.

This research in 1988 was the first to suggest possible deleterious effects of echoic training. The results throw light on the effects of reinforcing vocal attempts among children with severe speech related difficulties, to ensure attention and interest in speech related tasks (Dunlap, 1984; Skinner, 1962) and from a social validity perspective, make such teaching procedures more acceptable.

C. Milieu language teaching

Early research demonstrated the extreme difficulties in implementing therapy with children with autism due to minimal orienting responses, excessive stereotypy, lack of curiosity and joint attention, severe tantrums and neglect of environmental cues (Koegel & Schreibman, 1976; Rutter, 1966) which required years of training and discouraged professionals from providing treatment to them (Koegel & Traphagen, 1982). This resulted in researchers identifying key variables that may enhance therapy experiences for both the learner and instructor. Experimenters investigated the inclusion of reward systems and motivation as a key variable in treatments (Dunlap, 1984; Dunlap & Koegel, 1980; Egel, 1981; Goetz, Schuler, & Sailor, 1983; Koegel et al., 1987) as opposed to motor imitation of speech as the target behavior.

Milieu language teaching procedures include embedding teaching opportunities around a child's motivation in the natural environment. Incidental teaching (Hart & Risely, 1975) is one example of milieu teaching, where language teaching occurs during child initiated interactions with adult in an unstructured environment, such as play or daily routine activities. The study was conducted with 11 typically developing children between the ages 4.8-5.2 years from low-income families. All preschool materials were placed out of reach, but in view, so the child needed assistance to access the materials, to occasion an opportunity for incidental teaching. A mand such as "I want truck" was followed by cues from the teacher "Why?" or "What for?" so the child could use a compound sentence, such as 'I want a truck, so I can play with it'. The procedures were generalized with peers. Results suggested a significant increase in the variety of language usage. Incidental teaching thus was effective in increasing language in typical children.

Natural language teaching paradigm (NLP) was another procedure similar to milieu teaching, developed by Koegel, R. L., O'Dell, and Koegel, L.K. (1987) as an alternative to highly structured teaching methods like discrete trial training for teaching language to non-verbal children with autism. During the experiment the rate of vocal responding in nonverbal children with autism was assessed by manipulating certain variables, using NLP. The experiment involved two conditions, the analogue teaching condition and the NLP condition. During the analogue teaching condition the clinician selected targets, provided a vocal model "say ___" to evoke imitative vocal responses through successive trials on one target at a time, manual prompts were used like touching the tip of tongue or holding lips, and correct responses were reinforced with edible and social reinforcers. During NLP condition, the child selected the stimuli from a pool of preferred items, based on which the target vocals were selected. Before each trial motivation was ascertained making the presentation of targets random and instead of asking the child to "say…." the clinician played with the toy and presented the vocal model. If the child imitated the exact or a successive approximation, instead of an edible the vocalization was reinforced with the preferred instructional stimuli paired with social reinforcers. Results showed that immediate imitative responses (which occurred within 5 sec) as well as deferred imitative responses (which occurred when the response did not immediately follow the model and the clinician held up the object and asked "what is this?") were higher in the NLP condition. Generalization probes indicated a number of utterances outside the clinic setting. The research thus confirmed the hypothesis that training vocalization, when motivating operations were contrived, was in effect is likely to be more successful.

Laski, Charlop and Schreibman (1988) trained parents of children with autism to implement the use of NLP to increase their children's speech. Seven boys and one girl with autism between the ages of 5 to 9.6 years participated in the study. Of these, one child was functionally mute and had no receptive vocabulary. Three children were non-verbal and could imitate only sounds and a few words upon request, did not initiate speech and had less than 15 words in their receptive repertoires. Four children were echolalic with large vocabularies and could occasionally use previously trained short phrases, but rarely used speech spontaneously. To control for maturation effects and for comparison, the study included six neuro-typical children ages between 2.2-9.8 years matched by chronological and mental age. Parent training criteria included providing direct reinforcement for verbal attempt made by child; turn-taking with parent acquiring control of the toy 50% of times and modeling a target response like a verbalization about the toy; task variation and multiple exemplar presentation for e.g. model the word "open" when opening a box or a door; and finally, shared control for e.g. parent models "blow bubbles", however the child vocalizes "pop bubbles" followed by parent repeating "pop bubbles". Results suggested the child with the least vocalizations showed the greatest gains from a baseline of 0% vocalization to 29%. All other children also showed significant gains. Generalization of spontaneous speech in clinic free-play setting also showed a slight increase in the child with no speech. One of the biggest limitations of this study was all children were concurrently participating in a behavioral clinic program which may have impacted the acquisition of speech in the NLP training.

Gillett and LeBlanc (2007) replicated the study by Laski et al. (1988) with three children with autism who had little to no spontaneous language. All three could imitate words or phrases. The primary dependent variable was frequency of vocalizations. Results suggest that parent implemented NLP procedure increased spontaneous vocalizations in all three children. These findings regarding the impact of NLP on language were consistent with previous studies (Koegel et al., 1987; Laski et al., 1988).

Extensive research on milieu language teaching and NLP seems to be applicable to a broad population of children, however, the evidence for its effectiveness is not compelling as similar teaching procedures have been included in literature on the effectiveness of discrete-trial teaching (Goldstein, 2002; Hepting & Goldstein 1996). Significant differences in the effects of these teaching techniques were not found (Elliott, Hall, & Soper, 1991) although embedding teaching trials through the day had higher social validity and were more effective (Neef, Walters, & Egel, 1984; Secan, Egel, & Tilley, 1989). Importantly though, none of the studies were conducted with non-vocal children with a diagnosis of autism.

D. The Use of Individual Orienting Cues

Orienting cues have been used to facilitate speech acquisition and discriminated responding in children with learning disabilities. The effect of individual orienting cues prior to presenting verbal models was examined (Koegel, R.L, Shirotova, & Koegel K.L., 2009) with three children with autism who had a history of no functional words and no object-labels. Zane, Parker, and Alex were 3, 4.1, and 4.8 years old, respectively. During baseline measurement, when the participant demonstrated interest in an item or activity, the therapist provided a vocal model and delivered the item contingent upon an attempt to imitate. The items were also brought in view several times and held up to provide opportunities for spontaneous vocalizations. In the intervention phase, the individual orienting cues were used just prior to presentation of vocal model. Through a process of successive testing the researchers were able to identify orienting cues that were effective in getting the participants to attend. For example high-five was used with Zane, hugs, kisses, and novel sounds with Parker and an antecedent model for motor imitation with Alex. All participants showed increases in vocalizations compared to baseline conditions. This study suggests that pre-cursor events or orienting cues can facilitate word acquisition with some children with autism who have a history of not attending to vocal models or not responding to standard communication interventions. While some future studies added orienting cues as an additional variable, such as calling a child's name for an observing response (Petursdottir et al., 2011), or holding desired items at participants eye level to increase motivation (Carbone et al., 2010) it has not been used as an independent variable with non-vocal children.

E. Rapid Motor Imitation Antecedent (RMIA)

Ross and Greer (2003) believed that for non-vocal children with autism, establishing generalized motor imitation sequence before presenting a vocal model for imitation was an important first step to teaching them to speak. Prompting imitative vocal behavior in non-vocal children is difficult to facilitate, and shaping strategies though successful in evoking vocals in non-vocal children with autism and developmental disabilities (Lovaas et al., 1973; Sloane, Johnston, & Harris, 1968), are long drawn due to several stages of successive approximations involved in shaping. Ross and Greer (2003) explored the possibility of teaching a series of rapid motor imitations prior to the vocal model for the development of imitative speech. Five children with a diagnosis of autism and aged between 5.5-7.8 years participated in the study. None of the participants had spontaneous vocal speech; they did not imitate vocal speech and did not have generalized imitation. The intervention involved three stages. The stages included, imitating large (clapping) and small (touching nose or eyes) motor actions, reinforcing vocal approximations following a vocal model after a few large and small motor actions, vocal responding to mand probes during a 5s pause, wherein preferred items were brought in view. The intervention resulted in generalized imitation of vocal sounds for all 5 participants and mands were taught with the fading of antecedent imitation trials and vocal models. In the three-month follow-up probes, 4 out of 5 participants continued to mand using the words taught. The study was also successful in having the initial vocalizations to be identical imitations or close approximations obviating the need for extensive shaping procedures. Some of the limitations of this study were that most of the children required extensive motor imitation training, taking multiple school years to build this pre-requisite. Second, the number of training trials varied widely as trials were presented until satiation. Another significant limitation of the study was that four of the five participants emitted initial words similar to the model (e.g., candy), words as first vocalizations, suggested prior vocal speech could have been under stimulus control unknown to the experimenters and the procedures used facilitated vocal imitation.

Tsiouri and Greer (2003) replicated the study by Ross and Greer (2003) with two participants with further modifications. Both participants selected were under instructional control and could sit for 6-8 seconds, had generalized motor imitation in their repertoire and had no vocal communication skills. Participant A, was a 5-year-old male who followed one-step directions, inconsistently attended to his name, and made his needs known by leading others. He had no vocal communication and no echoic behavior. Participant B, was 3.6 years old male, could follow one-step instructions and respond to name and communicate by gestures and leading responses. He had no "spontaneous" vocal behavior and partially echoed some vocal sounds and syllables (ma/me/mo) inconsistently. The dependent variable consisted of four types of responses: emitting independent or echoic mands, both of which were defined as words or word approximations emitted by the participant in a presence of a highly preferred items and independent or echoic tacts both defined as words or word approximations emitted by the participant in a presence of a non-preferred item. The independent variable consisted of six rapid motor imitations with instruction "do this" and was combined with echoic to mand and echoic to tact trials. Results across both participants suggested emergence of first instances of echoics (mands and tacts) followed by independent mands and tacts. While this study identifies rapid motor imitation antecedent as a variable responsible for developing vocalization in children, the authors believe that this study may be similar to the phenomenon of behavior momentum, which is applied to the treatment of noncompliance (Mace & Belfiore, 1990; Mace et al., 1988).

It may be concluded from Tsiouri and Greer's (2003) research that of the two young participants, one already echoed some sounds and syllables however lacked "spontaneous" vocal behavior. It is not clear from these descriptions how many sounds and syllables did he echo? Was he able to echo under stimulus control? If he could already echo some syllables, what was the inhibiting factor in echoing more sounds and if previous efforts had been made in teaching him to vocalize using echoic prompts. It may thus be concluded that only one participant acquired vocals through the study while the second participant leaves various unanswered queries.

F. Stimulus-Stimulus Pairing (SSP) Procedures

Stimulus-Stimulus Pairing procedures involve a neutral or weak stimulus being paired with an established reinforcer repeatedly until the neutral or weak stimulus acquires reinforcing properties to become a conditioned stimulus. Behavioral accounts of vocalizations suggest that vocalizations, such as crying, screaming or coughing in infants begins with respondent conditioning and come under operant control when reinforced (for example, a parent giving food or warmth). Thereafter, unconditioned stimuli, conditioned stimuli, establishing operations and discriminative stimuli gain control over vocalizations, resulting in increased vocal responding. Initial vocalizations of an infant may occur due to deprivation of food, which functions as an establishing operation (EO) generating hunger pangs (an unconditioned stimulus), which may evoke crying (an unconditioned response). Crying behavior may result in getting food from someone in the environment. The approach of a person, an initially neutral stimulus, paired with availability of reinforcers, acquires properties of the reinforcers to become a conditioned stimulus (CS). Future crying may occur in the presence of a person (CS) as a demand for food. Over time the infant may learn to discriminate the caretaker as the provider of food. The caretaker in this case is a discriminative stimulus (S^D) for arrival of food in whose presence a variety of vocalizations may occur. For example, the initial vocalization “bububu” of an infant is maintained by automatic reinforcement, when it occurs under conditions of deprivation of food (establishing operation), and is attended by mother, who gives the infant a bottle of milk (reinforcer). Future “bububu” vocalizations are emitted due to operant conditioning, i.e., the infant’s vocalizations were followed by a reinforcing consequence. Thus establishing operations gain control over vocal behavior and the infant will make previously reinforced sounds to get his bottle of milk (mand). Soon, the bottle of milk may become a discriminative stimulus for saying “bububu”, which would be a partial mand and tact. Adults and caregivers reinforce at times variations of vocalizations when they resemble intelligible sounds. In addition the audio product of the infants’ own vocalization being heard by the infant could reinforce additional vocalizations through the mechanism of automatic reinforcement. This mechanism has been offered as an explanation for the extensive babbling of infants that is apparently without any human delivered reinforcement (Skinner, 1957).

Sundberg, M.L., Partington and Sundberg, C.A. (1996) empirically explored the role of automatic reinforcement (reinforcement not mediated by another human) in strengthening vocal behavior. One typically developing child and four children with moderate to severe learning difficulties between 2-4 years, participated in this study. Four subjects had vocals and could emit more than 200 mands, tacts and intraverbal responses except one child who had a few words in her repertoire. Words known to be novel for each participant were selected as targets. The study had three conditions, pre-paring or baseline, pairing condition and post-pairing condition. In the pre-pairing condition an adult without interacting with the child noted down the vocalizations of the subject and the controlling variables (EO, non-verbal stimulus or verbal stimulus). In the pairing condition, a familiar adult emitted a specific targeted vocal, varying the pitch and intonation every time and immediately delivered a preferred item or action (e.g., tickles, praise…). The words could be completely unrelated to the paired item or action. For instance the word "mirror" could be paired with a tickle or the extended vowel sound "eee" could be paired with being thrown up in a parachute by 4 adults. Each pairing session consisted of 15 pairings over a 1-2 minute period. After the pairing session the adult stepped back and took data as in pre-pairing condition. Results suggest that all participants emitted the target sounds in post-pairing condition and a significant increase in overall vocalization rate was also recorded. The study thus established that novel sounds could be acquired without direct echoic training by pairing the sounds with established preferred items or actions. The newly acquired vocals were observed to occur at other times throughout the day and overall vocal responses increased. With two of the participants, the vocalizations quickly turned into mands as they started using the previously neutral sounds to request preferred actions that accompanied them during training. For example, manding for head shakes with "Dee dum". In addition, with one participant the researchers were able to get a vocal "ee" under echoic control after all previously failed attempts. Some of the observations made at the end of the first experiment showed robust increase in vocalizations after pairing however the effects were temporary. The variables that affected new vocalizations were pairing frequency, reinforcement value, pairing history and establishing operations. An additional experiment was conducted to study the effect of pairing another phrase that sounded similar to the previous one. The experimenters paired the phrase “Name that sound” 25 times with tickles (reinforcer), for 110 seconds. This phrase was incompatible with an earlier phrase “What sound is that.” Results suggested the newly paired phrase was vocalized for 1.5 minutes after which the earlier paired phrase occurred at a high rate and this was again followed by the new phrase. This suggested the vocal responses can become a member of a response class. The empirical findings of this study indicate new forms of vocalizations can be acquired by children through pairing of neutral sounds, words or phrases with established conditioned and unconditioned reinforcers. New vocals already in the participant’s repertoire were acquired without direct echoic training, or vocal prompts or using direct reinforcement. However the authors reported failure in teaching the participants novel sounds using the pairing procedure. This study suggests the significance of automatic reinforcement as an independent variable in the acquisition of mother tongue by infants and its possible application among children with autism and other developmental disabilities.

Smith, Michael, and Sundberg (1996) extended the previous study by evaluating stimulus-stimulus pairing under neutral, positive and negative conditions. In the neutral condition, the adult presented a vocal phoneme 16.7 times/min but did not provide any preferred items. In the positive condition, the adult vocalized pre-selected phonemes and followed it by delivery of preferred item (e.g. bubbles or tickles). The negative condition included presenting a phoneme followed by a punisher already established like “bad girl” (with University Human Rights Commission’s approval). The pairing was done 5-times/20 sec for three sessions. Each of these procedures, as in the previous study had a pre-pairing, pairing and post-pairing condition where the experimenter recorded targeted and non-targeted vocalizations by the subject. Two typically developing infant girls, 11 and 14 months participated in the study. The target behavior was emission of recognizable phonemes. Certain specific phonemes, which had occurred at some point with the participants, were taken up as target vocalizations. Only one infant participated in the pairing under neutral condition and the aversive condition while both participated in the positive reinforcer condition. Results suggest, the neutral condition produced no change in the rate of production of target vocals in post-pairing session, the positive reinforcer condition produced a sharp increase in frequency of emission of targeted phonemes as well as well as a lesser but substantial rate of increase in vocalization of non-targeted phonemes for both the subjects. In the negative pairing condition, post-pairing of a targeted phoneme with a sternly spoken “bad girl”, the target phoneme vocalization immediately stopped and overall rate of responding dropped too. This study established that stimulus-stimulus pairing (SSP) procedures could be used to increase vocal play in infants. It also established the effect of aversive pairing in reduction of vocal responding. As in the previous study the authors were not able to account for the reasons why all pairing sessions were not effective and offered other possible variables, such as child’s emotional state at the time of experiment as possible confounds. They conclude that automatic reinforcement and automatic punishment play a role in the development of infant’s vocal verbal behavior and suggest that automatic consequences could be responsible for a wide range of differences observed in language abilities of children.

Yoon and Bennett (2000) conducted two experiments to investigate the effects of stimulus-stimulus pairing on conditioning vocal sounds as reinforcers. Four preschoolers with severe developmental delays, aged between 3-4 years participated. Participant A could imitate large gross motor actions, participants R and W could not imitate motor imitations. All participants had no vocal imitation skills. With respect to vocal play participant W could vocalize two sounds “duh-gha” and “sh” in free operant conditions while engaging in hand flapping while participants A, R and N did not engage in vocal play. In Experiment 1, a specific sound was selected for each participant and paired with reinforcing physical interaction. After a pre-pairing condition as in earlier studies, a pairing session was initiated with approximately 12 pairings per minute over a 3-minute duration. Post-pairing sessions immediately followed the pairing sessions and data indicated that stimulus-stimulus pairing was effective in increasing the occurrence of vocalizations of paired sounds by the participants. This supports previous finding from studies by (Smith et al., 1996; Sundberg et al., 1996; Yoon, 1998). However the effects of pairing were temporary with target vocalizations stopping after a mean of 9 minutes across participants. The target vocalization occurred for all participants immediately after the pairing. The authors conducted a second experiment to compare the effects of pairing procedure with echoic training. The study employed pre-echoic, echoic, post-echoic, pairing and post pairing conditions. A single subject design with a multiple baseline across participants was used and the experimenter recorded only the frequency of the target sound. The pairing procedure was identical to Experiment 1 and was used to establish automatic reinforcement contingencies. In the echoic training condition the experimenter emitted a target sound and delivered an established reinforcer contingent upon an echoic response. The results in the pairing and post-pairing sessions were similar to those in Experiment 1; namely, an immediate increase in vocalizations at the start of post-pairing session and extinguishing after a certain period of time. For all the three participants the echoic condition had no immediate effect on target vocalizations. This study was thus able to confirm that even for persons with severe communication delays vocalization can come under stimulus control with stimulus-stimulus pairing procedures which may be necessary before echoic training for children with low vocal verbal repertoire. This study is significant as the four of the five participants had no vocal play and none of them had vocal mands or echoics in their repertoire unlike previous studies (Smith et al., 1996; Sundberg et al., 1996), and the target sounds were not observed in free operant settings. One participant who had a history of vocal play demonstrated a higher and dramatic increase in the rate of vocalizing target sound as compared to others. Results suggest that history of reinforcement and the ability to make oral motor responses could be variables, which have an effect on vocalizations not part of the participants' vocal repertoires. The authors suggest that if sentences were selected as target sounds the participants would not have demonstrated the same rate of increase. They also observed variability in sounds produced (e.g., "euh" or "ahm" instead of "ah") were observed in the extinction phase just as the Sundberg et al. (1996) study. Overall this study strengthens the body of previous research.

Miguel, Carr, and Michael (2002) list some of the limitations of the previous studies. All the demonstrations of intervention effects were across minutes in a single session leaving it unclear as to whether SSP sessions can produce effects beyond the immediate post-pairing sessions. Miguel et al. (2002) identify common methodological limitations in all the above three studies (Smith et al., 1996; Sundberg et al., 1996; Yoon & Bennett, 2000). Firstly, the number of pairings across sessions and participants varied, secondly none controlled the possibility of adventitious reinforcement during pairing sessions, thirdly two studies (Smith et al., 1996; & Sundberg et al., 1996) did not employ strategies for demonstrating experimental control over the independent variable, such as reversals or replication across behaviors within participants and finally the increase in vocalizations was demonstrated only during a single session. The authors addressed these issues and maintained a consistent number of pairing trials per session, compared the procedural efficacy over larger units of days and controlled for adventitious reinforcement of targeted sounds during pairing sessions. The duration of pre-pairing, pairing, and post–pairing sessions were 5 minutes, 3 minutes, and 5 minutes respectively. Three children aged 5, 3 and 5 years participated in the study. They all could emit a few sounds but did not have any repertoire of functional speech (mands, tacts or intraverbals). A two tiered multiple baseline across vocal behaviors for each participant was used with a short duration reversal to baseline towards end of the study. For one participant there was an immediate increase in vocalizations across two phonemes in post-pairing sessions and for the second participant there was an immediate increase with one of the target vocalizations. In all these instances during reversal to baseline conditions there was no significant difference in vocalizations between pre and post-pairing demonstrating clearly that it is the intervention that is responsible for increase in vocalizations. The effects were temporary in this study too as evidenced by low levels of vocalization in subsequent pre-pairing conditions compared to vocalization in post-pairing sessions. The authors of this study proposed that the temporary effects were perhaps due to extinction effect as no form of conditioned reinforcement followed emission of target vocalizations in the post-pairing sessions. With a third participant, the pairing procedures were ineffective in increasing vocalizations. During the analysis of sessions where pairing was not effective, the study offers an additional hypothesis. As with Bennett and Yoon (2000), it was suggested that the less advanced a child’s vocal verbal repertoire the more responsive the child is to the pairing procedure. This could be attributed to the fact that children with more extensive repertoires can access competing reinforcers through mands or intraverbals.

Esch, Carr, and Michael (2005) attempted to bring vocalizations acquired by pairing under echoic control. Secondly they aimed to establish the effect of increased post-pairing vocalizations. In a third experiment they attempted to study the extent to which vocalizations that were acquired by SSP procedures could be clinically brought under direct reinforcement contingencies using a simple shaping procedure. Three children Alexa, David and Jodi aged between 6-8 years, who had no vocal verbal repertoire participated in the study. The experimental design in the first experiment had three conditions. In the first experiment, following pairing sessions, the newly acquired vocals could not be brought under echoic control with direct reinforcement of echoic responding. This brought forth a question as to whether there would have been an increase in vocalizations of target sounds if there were no echoic reinforcement contingencies in place. To test this a second experiment along the lines of Miguel et al. (2002) was conducted with two participants. It was found that there was no increase in frequency of targeted words with either participant in post-pairing sessions as observed with one of the participants in Miguel et al. (2002) study. In addition, this failure to produce an increase in vocalization with pairing procedures with both the participants who had a weak vocal verbal repertoire calls into question one of the hypothesis of Yoon (2000), that children with low pre-existing vocal verbal repertoire would be more receptive to pairing procedures and show better increases in rate of vocalization in post-pairing sessions. Esch et al. conducted a third experiment wherein they used a non-concurrent multiple baseline design with a baseline condition followed by a differential reinforcement of targeted vowel condition. In the latter condition, the experimenter delivered a previously established reinforcer such as hugs or tickles as soon as the participant vocalized a vowel sound. One participant showed an immediate increase in vocalization of the targeted sound while no increase was observed in the second participant, during the differential reinforcement phase. The latter result, according to the authors could be because the putative reinforcers with the second participant were not strong enough and is substantiated with certain anecdotal observations of the participant returning the delivered reinforcers while shaking his head to indicate “no”. This study, taken together with Miguel et al. (2002) indicates that the efficacy of pairing procedures may not be uniform across participants and additional variables that affect increasing or suppressive effects on vocalization need to be studied.

Normand and Knoll (2006) extended the study by Miguel et al. (2002) by adding another observation period of 60 minutes after each pairing session. In addition the pairing procedure and number of vocal pairings per pairing trial was also varied. Evan, a 3 year-old boy with autism who could tact many items and mand vocally for a few items participated in the study. Baseline data were taken by recording target vocalizations over a 20 minute free-play period. In a control condition, a phoneme was emitted 7 times with a preferred stimulus delivered after 30-seconds. During the pairing condition, the experimenter emitted the target phoneme 7 times, with the preferred item or activity being delivered after the 4th vocalization. Neither the control session, nor the post-pairing session nor the 60 minutes follow up post-pairing observations showed any significant increase in vocalization over baseline levels. Of the 29 sessions there were three sessions when the 60-minute post-pairing follow up session showed high levels of vocalization but these were explained as effects of unintended establishment of mand repertoire. This participant's verbal repertoire was at a higher level (Level 4, BLA) than the one in Miguel et al. study (Level 3, BLA) and increase in vocalizations were not observed as with one of participants in the Miguel et al. study.

Yoon and Feliciano (2007) selected 6 participants with varying vocal verbal repertoires to examine if vocalizations acquired by an SSP procedure can be acquired as mands under the control of motivating operations. Two participants had high verbal repertoire with low vocal play, two had low/mid level repertoire with high vocal play and two participants had low verbal high vocal play. Verbal repertoire was determined on the basis of number of mands, tacts and intraverbals in the participant's repertoire and level of vocal play was determined by rate per minute of the number of vocals emitted by the participant during observations. Reinforcers were selected on the basis of items or activities that had a history of increasing participants' responding in their classroom programs. Pre-pairing, pairing, post-pairing and direct reinforcement conditions were used. Pairing sessions lasted approximately 3 minutes with 12 pairings per minute. In the direct reinforcement conditions if the participant tried to access a preferred item, it was given only if he emitted at least an approximation of the sound. For each participant a different sound was targeted for pre-pairing, pairing and post-pairing sequence and pre-pairing, pairing and direct reinforcement sequence. Three of the 6 participants (H, JA, MC) did not show any increase in vocalization in the direct reinforcement condition though H and MC emitted higher vocals during pairing condition. One participant JA showed an increase in the post-pairing condition. The vocal targeted for direct reinforcement did not occur in post-pairing session for JA at all. With two participants (JOA and A), responses increased in both post-pairing and direct reinforcement sessions. An interesting observation with these two participants is that vocalizations continued without extinguishing in the direct reinforcement condition whereas it eventually extinguished in the post-pairing session that did not have a direct reinforcement contingency. The latter phenomenon of vocalizations extinguishing in post-pairing sessions is in line with reports from all earlier studies. A mand contingency may thus help strengthen a newly acquired vocal and shape it into a verbal operant. Apart from these two (JOA and A), three participants failed to vocalize in post-pairing condition and four failed to vocalize in the direct reinforcement condition. The authors offer certain hypotheses that could explain the failures in some measure. Two participants had strong tact repertoires and hence could fail for the same reasons that participants with higher verbal repertoires did in previous studies, namely that they are able to access reinforcers through other direct reinforcement contingencies. One participant MC, had vocalizations emerge during the pairing sessions where in it is difficult to determine the function of such vocalization (was it mand or echoic or tact?). It is then surprising that the vocalization did not occur post-pairing as a mand in the direct reinforcement condition. JA, who had a high rate of vocal play had target vocalizations emerge in post-pairing condition but not in direct reinforcement condition suggesting automatic reinforcement controlling his vocal behavior that is also evidenced by high rate of free vocal play. Participants H and JI did not produce any vocalization in the post-pairing or direct reinforcement conditions but participant H did vocalize twice during pairing sessions. This again is one of the few studies where vocalizations during pairing sessions are reported and examination of the same in relation to presence or absence of vocalizations in post-pairing sessions could offer some idea about the relative influence of automatic and direct reinforcement mechanisms. One additional insight in this study is that participants with low vocal verbal repertoire but higher rates of vocal play were the ones that showed an increase in vocalization post-pairing. For persons with stronger vocal verbal repertoires the authors suggest exploration of higher order communication or novel vocalizations. With these two subjects the mand contingency was more effective in sustaining the vocalization compared to automatic reinforcement as evidence by more rapid extinguishing of the vocals in the post-pairing condition compared to direct reinforcement condition. In the case of participants who did not vocalize in the direct reinforcement sessions, satiation during pairing sessions may have interfered with establishing operations, which are required for emission of mands. The number of pairings and length of pairing sessions also would require additional examination.

Stock, Schulze, and Mirenda (2008) studied three participants Jay, Sara and Jane. Jay was able to mand for 10 items using picture exchange however he could not echo or label items vocally. Sara was able to vocalize a few sounds such as “ba”, “na”, “ma”, “da” with intonation and use a few words however did not use vocals on demand. Jane manded for 10 items using pictures and produced seven different sounds. Prior to intervention she started echoing three sounds “puh”, “ah” and “mmm”. The study involved baseline, control, stimulus-stimulus pairing and echoic training procedures. The control condition involved the experimenter saying the target vocal 5 times/trial and delivering an established reinforcer 10 seconds later. If a target sound was emitted in the delay period, the putative reinforcer was not delivered. Each session lasted 10 minutes with one trial done every 20 seconds with a total of 30 trials per session. This study confirmed some of the early findings. SSP may not be uniformly effective in increasing vocalization. A total of 10 children participated in SSP studies with 70% not showing increase in vocalization and hence a suggestion that SSP procedure would be less effective with children with autism than for those with other developmental disabilities. This has to be seen in conjunction with a number of other variables such as pre-existing verbal repertoire level, intensity of pairings, reinforcer strength, experimenter familiarity, and voice intonation during sound presentation. While the effects were not very different between control, echoic and SSP conditions, there were anecdotal reports that happiness indicators such as smiling and laughing were much higher in the control and pairing conditions. In fact, they reported a dramatic change in emotional behaviors for the worse whenever the echoic condition was introduced. A second possibility based on a record of pairings per minute and number of pairings in earlier studies versus recent ones is that more pairing trials with fewer sounds paired per trial could be more effective. This could be because with a higher number of sounds paired the sound may be paired with withholding the reinforcer rather than with access. They make a suggestion that it may be preferable to make only one sound per pairing so that reinforcement follows every stimulus presentation. Further Stock et al. also state that for two children whose sessions were post-meal the relevant motivating operations may not have been in effect due to the reduced value of edible reinforcers. The effect of satiation with presentation of a limited number of reinforcers across several 10s of pairing trials also presented a confound, which affected reinforcer effectiveness in turn affecting the effectiveness of intervention itself. A familiar experimenter, it is said, could also serve to enhance the effectiveness of putative reinforcers and is another variable that the authors recommend be described and captured in future studies. In the current study Stock et al. presented sounds in a neutral tone with no emotional affect during pairings unlike the study by Sundberg et al. (1996); this could be an independent variable in itself effecting vocalizations and could be studied. Based on cumulatively available data the authors conclude that with the current variants in procedure SSP cannot be reliably used clinically to increase vocalizations in the autism population.

Carroll and Klatt (2008) extended the study on two very young 22 and 23 months old children with autism. Mary's language repertoire at intake consisted of a few vocals however no echoics, mands or tacts while Max had a strong echoic repertoire, could mand and tact however had limited intraverbal language. This study addressed the effect of previous conditioning history based on attempts to teach children with autism to speak. An under two year-old would more likely have a briefer conditioning history as compared to most of the higher aged children with autism in the previous studies. The target sounds were one low frequency or novel sound and one sound frequently emitted by the participant. The experimenters used a session of 20 SSP trials with 3 sound emissions from the experimenter followed by 20-second access to reinforcers identified by a brief multiple stimulus preference assessment conducted before the session. The SSP procedure resulted in immediate increase in vocalization of known target sound for Mary, the participant with lower language repertoire. Unlike the previous experiments where the vocals extinguished in post-pairing sessions, with Mary the vocalizations were maintained in the 5-minute post-pairing sessions. However the maintaining variables could not be confirmed, and the author suggests that automatic reinforcement, or adventitious intermittent reinforcement, by parents or therapists could be at work. There was no increase in novel sounds though it occurred at a low frequency during a second experiment involving a direct reinforcement condition similar to the standard echoic condition in previous studies. SSP procedure was not successful with the second subject, Max, in increasing frequency of a known sound, and hence intervention targeting a novel sound was not even attempted. The results conform to findings from a previous study (Normand & Knoll, 2006) where SSP was effective in increasing vocalization only in children with lower vocal verbal abilities. In addition, Mary's vocalizations were brought under echoic control successfully replicating the results with one participant in the Sundberg et al. (1996) study. In the control condition, the sound was said several times and the experimenter would wait for 20 seconds before delivery of putative reinforcer. Such a procedure could make the item or action paired with extensive withholding of the reinforcer and thus interferes with results in subsequent sessions.

Esch, Carr, and Grow (2009) evaluated an enhanced SSP procedure that included presenting an unpaired stimulus (S-) along with a paired stimulus (S+). The S- trials did not contact reinforcement and were interspersed with S+ trials that had the target sound as antecedent stimulus and contacted reinforcement. An attending prompt "look" was given before the trials, motherese (exaggerated prosody vocals) speech (Falk, 2004) used for both S+ and S- presentations and finally varied inter-trial intervals were used to eliminate temporal predictability during SSP. Three children, between 2.4-5.7 years with a diagnosis of autism participated in the study. In terms of their verbal repertoire, participant 1 had no echoic, and low frequency vocal play; participant 2 displayed frequent vocal play, without functional verbal behavior; the third participant engaged in frequent vocal play with a few mands, tacts and intraverbals. Baseline, SSP and programmed reinforcement conditions were conducted within every trial. A Non Contingent Reinforcement (NCR) condition was added in which reinforcers were delivered for 5 minutes on a 30 second fixed interval schedule. In this study, target vocalizations of all subjects increased slightly over baseline levels during SSP condition, and at higher levels during programmed reinforcement condition. In the subsequent NCR phase maintenance without extinguishing was observed only with the participant with the least verbal repertoire at intake. As with other studies, the performance varied across participants making it difficult to pinpoint the facilitating variables and blocking variables. In the current study, within session data were collected in the pairing session too. Whenever vocalizations occurred during pairing sessions, a 20-second delay to reinforcement was introduced to correct for adventitious reinforcement. However such a correction could also act as a punisher and serve to suppress overall responding. The introduction of S- served to demonstrate control as the increases in S+ responses (target vocalizations) were higher than the increases in S- responses (non target vocalizations that did not contact paired reinforcement) in the SSP phase as well as direct reinforcement phases. As the responses decreased for both participants during the NCR condition, this suggests that direct reinforcement contingencies possibly played a larger role than automatic reinforcement contingencies. However, with one participant the maintenance of target vocalization in NCR condition suggested a greater influence of automatic reinforcement. While analyzing the failure of SSP procedure with some participants to increase vocalizations the authors also suggest ‘listener responding skills’ as a possible pre-requisite for SSP procedures to be effective. The premise is that a poor repertoire of responding to others voice also comes in the way of one’s own auditory emission serving as reinforcement.

Petursdottir, Carp, Matthies, and Esch (2011) explored and offered some additional factors that could account for failure of SSP procedures in some cases. Reinforcer effectiveness has been identified as a factor in earlier studies. The stimulus that is paired with the vocal may not be effective as a reinforcer. Overshadowing, blocking and conditioned stimulus (CS) pre-exposure can affect SSP procedures. In a SSP trial, the auditory stimulus emitted by the therapist may be overshadowed by the visual stimulus of the therapist’s lip movements. A blocking effect could occur when a therapist while emitting a sound also reaches for an edible or other reinforcer, the latter action could block the emission of speech sound from the participant. Pre-exposure to the auditory stimulus during baseline and control conditions could prevent such stimulus from getting conditioned effectively. Also, if the auditory stimulus lacks salience this could affect stimulus-stimulus pairing. In addition, other parameters of the intervention studied earlier such as number of pairings, number of trials per session, session duration could also play a role in the effectiveness or otherwise of pairing. The variables manipulated by Petursdottir et al. in the study were frequency of preference assessments, elimination of pre-session exposure to target vocalization, number of pairings per session, use of observing prompt, interspersal of target stimulus pairings with a control stimulus to prevent overshadowing and control stimulus exposure and elimination of experimenter’s actions that could block responses. Another interesting variation in this study was the use of a button press response to produce target sound vocalization to ensure salience of the auditory product produced. Two participants, Brandon and Brennan, 4 year-old twins with autism with high levels of vocal play and high echoic and mand repertoires and Dominick a 3 year-old with infrequent vocal play and no verbal operant participated. Only one participant, Brandon, showed increases in responding to a button that produced the auditory stimulus equivalent to the target sound in a pairing condition which had pre-session stimulus preference assessments. However, in the reversal session that followed the allocation did not change to the control stimulus. The results of this study do not offer a clear idea of the variables or their magnitude that could reliably increase the effectiveness of SSP procedures.

Miliotis, Sidener, T.M, Reeve, Carbone, Sidener, D.W. et al. (2012) compared the effects of 1 sound per pairing trial with 3 sounds per pairing trial with 2 children with autism. Two participants, one with no echoics and low vocal play, and a second with six echoic responses and low vocal play participated. Two target vocalizations (S+) and two non-target vocalizations (S-) were used in an alternating treatment design with 4 conditions designated as 1:1 S+ (one presentation of target sound/trial), 1:1 S- (one presentation of non-target sound/trial), 3:1 S+ (3 presentations of target sound/trial) and 3:1 S- (3 presentations of non-target sounds/trial). Brief stimulus preference assessments were done each day, pre-trial attending prompts were used and correction delay of 20 seconds as in earlier studies was used. For both participants substantial increase in vocalizations occurred in only 1:1 S+ condition providing what the authors called a preliminary support for use of a 1:1 S+ pairing procedure. The limitations of the study include difficulty in selection of four targets for each participant of similar difficulty level.

Rader, Sidener, T.M., Reeve, Sidener, D.W., Delmolino, et al. (2014) replicated the enhanced SSP procedure used by Esch et al. (2009) with interspersed target and non-target trials and presentation of vocalizations in "motherese" speech. Three participants 4.6-7 years, participated in the study; all had low frequency vocal play, and emitted 5-6 English Phonemes (of 42). For two of the participants, the increase in rate of vocalization from baseline was substantial for targeted vocals (S+) while the increase was negligible for non-target vocals. The ineffectiveness of the procedure with the third participant could be attributed to problem behaviors such as crying and hitting observed when preferred items were removed. In light of the fact that vocalizations had not increased with two participants during echoic or mand training, the findings suggest that SSP can be effective where other procedures have failed to increase vocalizations. The reason for this is not well known.

A review of 13 studies conducted between 1996-2014 using SSP conducted by Shillingburg, Hollander, Yosick, Bowen and Muscat (2015) offer evidence that the technology can be useful in increasing vocalization of children with autism who have low vocal verbal repertoire and whose vocalizations have failed to increase with echoic training or mand training or other procedures. Such emergent vocalizations can be brought under control of motivating operations or verbal or non-verbal stimuli facilitating the acquisition of functional speech in the form of mands, tacts and intraverbals. There are however some limitations. Firstly the procedures have not been uniformly successful across participants leaving the question of optimal combination of variables open and needing additional research. Further where successful the effects were transient in most cases with vocalizations extinguishing within 5 minutes of the post-pairing session.

G. Alternative Augmentative Communication (AAC)

Augmentative and Alternative Communication (AAC) systems are often recommended for those on the autism spectrum who have limited vocals (Lloyd, Fuller, & Arvidson, 1997; Romski & Sevcik, 1997; Sigafoos, Schlosser, & Sutherland, 2010). AAC serves the purpose of supplementing or augmenting natural speech and may also support in the development of vocal speech (Light, Beukelman, & Reichle, 2003; Schlosser & Wendt, 2008), providing an alternative for communication (Beukelman & Mirenda, 2005).

AAC's are classified as unaided or aided. Unaided AAC includes manual signing, gestures or finger spelling and requires only the use of body parts to communicate (Fuller, Lloyd, & Stratton, 1997). Aided AAC includes selection based methods such as graphic symbols, selection of symbols in speech-generating devices (SGDs) with synthesized or digitized speech output, and exchange based approaches such as the Picture Exchange Communication System (Bondy & Frost, 1994).

Some authors have suggested that using AAC interventions may play a facilitative role in speech production in children with autism (Blischak, Lombardino, & Dyson, 2003; Frost & Bondy, 2002; Sundberg et al., 1996). However speech-language pathologists as well as families of children with autism have always been concerned about AACs due to the perception that they may lead to dependence and become obstacles to vocalization (Schlosser, 2003).

G.1 Picture Exchange Communication System

The picture exchange communication system (PECS) was developed as a method of communication (Bondy & Frost, 1993) for persons with autism using visual graphic symbols or pictures and involves giving a picture to another person in exchange for a desired item (e.g. toys, edibles, drinks), tacting or terminating an aversive stimulus. PECS training protocols were defined by Frost and Bondy (1994) and included six steps. These were (a) physical exchange of picture with desired item, (b) seek picture, walk to a communicative partner and give picture, (c) discriminate between pictures and select as per need, (d) make a sentence structure using “I want ____” to request, (e) respond when asked “what do you want”, and (f) use the PECS board to comment.

PECS training has resulted in the development of speech, spontaneous communication skills (Bondy & Frost, 1994; Ganz & Simpson, 2004; Kravitz, Kamps, Kemmerer, & Potucek, 2002; Schwartz, Garfinkle, & Bauer, 1998), increased length of utterance and complexity of sentence. Charlop-Christy, Carpenter, LeBlanc and Kellet (2002) used PECS with three children Alex, Jake and Kyle diagnosed with autism. All three children could imitate speech however could not initiate communication. PECS training was provided in free play and academic settings. Results demonstrated increase in speech as the most important finding. Spontaneous speech for Alex increased to 100% from a baseline of 28%, Jake showed an increase to 83% from nil while Kyle displayed spontaneous speech from nil to 63%. The mean length of utterance during spontaneous speech also increased for all three. This study was the first to provide empirical support to the efficacy of PECS training. The authors mention that all children displayed an ability to imitate which could have impacted gains in verbal behavior.

Tincani, Crozier, and Alazetta (2006) studied two older children aged 10 years 2 months and 11 years 9 months with autism with the primary objective of assessing effect of PECS alone in acquisition of mands and a secondary objective of assessing effects of PECS in acquisition of speech. Vocalizations for one participant after an initial decline increased to 87% in the final phase. The second participant did not demonstrate any measurable speech. A third participant aged 9 years 2 months who joined Phase 2 of the study showed improvements in vocal approximations when a delay to reinforcement of 3-5 seconds was introduced.

Jurgens, Anderson and Moore (2009) used PECS with one participant aged 3 years 7 months having a diagnosis of mild to moderate autism with unintelligible speech and delayed echolalia. Intervention occurred using highly preferred items. Results suggested rapid acquisition of communication within 16 sessions and concurrent improvements in vocal speech wherein morpheme utterances increased from a daily mean of 10. 7 in baseline to 42.2 and word repertoire increased from 14 words in baseline to 77 words.

Canella-Malone, Fant, and Tullis (2010) reported improvements in requesting with PECS in two individuals, a 14 year old female with PDD-NOS who depended on prompts for engaging in verbal communication and a 6 year old female with severe autism who used sign-language, three word phrases and a device sporadically with adults but displayed aggressive behavior with peers.

Stoner, Beck, Bock, Hickey, Kosuwan, and Thompson (2006) implemented communication training using PECS with five nonspeaking adults 22 to 31 years in age with mental retardation. Outcome of the study suggests the intervention was effective with adults as three of the participants acquired functional communication and generalized across settings; there was however no reports on their vocalization.

Greenberg, Tomaino and Charlop (2014) investigated the effect of training in PECS on vocalizations in four boys with autism aged 4 years 2 months and 8 years 4 months. None of the children could mand using words, two of them could not imitate while two could imitate a maximum of two syllables. A multiple baseline research design across participants with PECS as the independent variable was employed in free play sessions and results of the first study suggested one participant remained non-vocal while three participants demonstrated an initial decrease in vocalization with an increase at follow up. The authors conducted a second study in which vocalizations were paired with use of PECS and time-delay and prompt-fading procedures were used. This was described through the three-term contingency as: MO present while preferred item out of view → exchange picture + vocal pairing → access to preferred item. Two participants from study 1 who could imitate consonant-vowels were included in the study. A time delay of 3 seconds was introduced when the participant exchanged the PECS sentence and therapist paired the vocal and waited for 3 seconds, if the child vocalized the preferred item was delivered however if there was no vocalization the therapist repeated the model thrice and delivered the item only if the child vocalized. Results suggest both participants emitted vocals on 90% and 100% trials during the delay phase and the time-delay and prompt-fading phase respectively.

Recent reviews of literature on PECS and speech provide evidence that using PECS does not decrease speech usage (Hart & Banda, 2010) or prevent its emergence. Improvements in vocalizations have received mixed evidence with most studies suggesting improvements (Carr & Felce, 2007; Tincani, Crozier, & Alazetta 2006; Yoder & Stone, 2006) with some stating no improvements (Ganz et al., 2010; Howlin, Gordon, Pasco, Wade, & Charman, 2007).

Using PECS for developing communication has shown to be socially valid although the aim of PECS was not to evoke vocalizations (Sulzer-Azaroff, Hoffman, Horton, Bondy & Frost, 2009); the challenges included teaching orienting and discriminating between pictures (San & Abdullah, 2013) or selecting alternative pictures when one item has highest preference. A meta-analysis of all PECS research by Fliopin, Reszka and Watson (2010) reported 'small to negative' finding related to production of speech. PECS may also find limitations with individuals with severe physical disabilities, which may hamper the ability to manipulate icons (Conklin & Mayer, 2011).

G.2 Manual Sign Training

Gardner and Gardner (1969) were the first to teach effective communication to an infant chimpanzee using sign language. Sundberg 1996, studied its effects on children with autism which led many researchers to confirm that acquiring manual sign supports the development of verbal and non-verbal operants like mands, tacts and discrimination (Bonvillian & Nelson, 1978; Carr, 1979; Carr & Kologinsky, 1983; Hurlbut, Iwata & Green, 1982; Sundberg, 1980).

An initial study using sign language training, was conducted by Carr and Kologinsky (1983) with six children with autism. All children between the ages 4 years 9 months to 14 years had limited receptive language and had failed to acquire any functional expressive speech. Three of these had participated in an earlier study (Carr & Dores, 1981) and used sign language to label items. The independent variable consisted of using prompts, fading prompts and using differential reinforcement to teach manual signs. Results of experiment 1 suggested all three participants acquired manual signs for communication. Experiment 2 with the remaining three participants indicated generalization of signs across settings was achieved. Authors of the study reported that the independent variable did not include providing a vocal model during manual sign training despite previous investigations (Schaeffer, 1978; 1980) which suggested possible speech acquisition at a later stage, as they observed the participants to be unresponsive to speech and seemed confused when speech was paired.

DiCarlo, Stricklin, Banajee, and Reid (2001) studied the effect of manual signing in an inclusive early intervention classroom with toddlers with and without disabilities. 12 toddlers with and 11 without disabilities participated in two groups during the study. All communicated using single word approximations and except one all could imitate motor actions. A multiple baseline across the two groups of children and three activities was conducted. Results suggested verbalizations for children with disabilities during baseline and target activities using manual signs were 20% and 24% respectively while with children without disabilities were 26% and 28% respectively. The study concluded that introduction of manual signs to communicate desire during using signs has no reductive effect on vocalizations.

Bartman and Freeman (2003) conducted a study with a 2.3 years old girl with autism whose communication was at 3 months (Vineland Adaptive Behavior Scale Domain) level. She was taught in an enriched environment with high value preferred items and was taught to request using signs with physical prompting and fading. Three target signs were identified and each sign was paired with vocals. The child used her first independent sign to mand in the 21st session and acquired her fourth sign in only 9 sessions. During this period she also vocalized with the signs however no data was provided on the same.

Scattone and Billhofer (2008) taught a 8 year old non-vocal boy with autism to communicate using signs. A speech and language pathologist determined absence of mands, tacts or intraverbal language repertoire. The intervention included mand, tact and intraverbal training using signs. Mand training was initiated after a preference assessment and selection of five preferred items as targets. Two instructors were involved, one sat in front who presented the model and another sat behind the child to provide a prompt if necessary. A teaching trial consisted of placing a preferred item in view and out of reach. When the child reached out for the item the instructor modeled a sign while saying the word. If the child did not sign he was prompted physically from behind and the preferred item was delivered. Tact training included showing common items e.g. hat, shoes and asking "what's this?" Intraverbal training was provided for items on which signs were acquired as either mands or tacts. The instructor asked the child to "sign __" while the item was not present. Prompting procedures were identical to mand trials and reinforcers were provided after prompted and unprompted trials. Results suggest mands were acquired in fewer sessions (6 to 26 sessions) than tacts (28 to 51 sessions) while intraverbals took (3 to 38 sessions). There were no vocalizations observed. Both the above studies included a single subject and did not demonstrate experimental control of the independent variable.

Carbone, Sweeney-Kerwin, Attanasio and Kasper (2010) combined the sign mand training procedures with vocal prompts and prompt delay with three children who did not have any consistent or functional vocal responding and were successful in increasing the number of vocal responses concurrent with signs for all three. Their study supports prior findings that manual sign training does not suppress vocalization and that there could be gains in speech production for children with autism with limited vocal-verbal repertoire. Carbone (2012), refers to Koegel, O'Dell and Dunlap (1988) and Drash, High and Tudor (1999) for the efficacy of vocal prompts during mand training procedures in increasing speech production in children with autism. The effectiveness of manual sign language in facilitating vocal verbal behavior is attributed to the sign acting as an additional sensory cue for children with autism (Barrera et al., 1983).

Manual-sign training with the simultaneous presentation of an associated spoken word (Carr, 1979) is also referred as "total communication". Research suggests non-vocal children's communication greatly improves and vocal responses are facilitated when non-vocal children with autism are taught sign language (Brady & Smouse, 1978; Barrera et al., 1980; Barrera & Sulzer-Azaroff, 1983; Casey, 1978; Carr, 1979; Clarke, Remigton, & Light, 1988; Fulwiler & Fouts, 1976; Goodwyn, Acredolo, & Brown, 2000; Konstantareas, 1984; Konstantareas, Webster, & Oxman, 1979; Layton & Baker, 1981; Schaeffer, Kollinzas, Musil, & McDowell, 1977; Sisson & Barrett, Tincani, 2004). When training under sign-alone and simultaneous communication condition was compared the latter was found to be much more effective in producing acquisition of expressive language (Barrera et al., 1980). Use of total communication facilitated complex speech (Konstantareas, 1984), increased the length of utterance (Sisson & Barett, 1984), and improved vocal labeling (Barerra & Sulzer-Azaroff, 1983, Carbone, Lewis, Sweeney-Kerwin, Dixon, Louden & Quinn, 2006). Gains have also been much more effective in those who already had an echoic repertoire.

Tincani (2004) compared sign-language training with vocal model with PECS on acquisition of mands and vocal behavior. The study included two participants Carl and Jennifer aged 5 year 10 months and 6 years 8 months respectively. Both participants could echo some words however did not use speech without prompts. An alternating treatment design was used and results suggested by session 25 Carl's independent mand using signs increased from nil to 34.1% while his vocalizations increased to 46.3%. During PECS training his mands increased to 7.6% and he emitted vocal words in 22.3% of opportunities. Jennifer's independent mands increased from nil in baseline to 12.9% during sign language while she emitted word vocalizations at an average 93.4% of opportunities. During PECS training her independent mands increased to 59.6% while her word vocalizations were 77.9%. The authors report more word vocalizations for Jennifer during sign language training with vocal models. This study reports mixed findings and suggests PECS could be more appropriate for participants with autism and fine motor difficulties however sign language training produced higher vocals for both participants. It was also observed that both participants emitted vocals immediately following a sign suggesting signs could have acted as prompts for the emerged vocals.

G.3 Speech Generating Devices

Speech generating devices (SGD) were first used as options for communication in the 1990s with widespread use in the last decade. An SGD is a portable electronic device with a variety of symbols which may serve as selection-based responses. On activation they produce a digitized or synthesized speech output such as "I want ___". The SGDs have been used to teach individuals with speech delays to mand for preferred items or activities (Lancioni, Reilly, Cuvo, Singh, Sigafoos & Didden, 2007), greet and answer questions.

Roche, Sigafoos, Lancioni, Reilly, Schlosser et al. (2014) taught two participants to communicate using a tablet computer-based SGD. One 9 years old participant with a diagnosis of autism communicated using gestures and sounds, labeled three objects, made one word requests inconsistently and engaged in echolalia by repeating names of cartoon characters. The other participant was 3 years old with global developmental delays and made babbling sounds. Results suggest, both participants showed an increase in using natural speech after learning to use SGD providing empirical support to previous AAC interventions facilitating speech production (Greenberg, Tomaino, & Charlop, 2013; Millar 2009). An increase in natural speech production, was reported by Parsons and La Sorte (1993) in their study with six children with autism using an SGD. However in another study on five children with very low vocalizations (Schlosser, Sigafoos, Luiselli, Angermeier, Schooley, Harasymowyz & Belfiore; 2007) four did not demonstrate any increase in vocalizations. Using SGD's have thus demonstrated mixed effects on increasing vocalizations.

G.4 Comparison of Aided and Unaided AACs

Various studies have compared the effects of AAC on improvements in speech production. Tincani (2004) compared the rate of acquisition of mands using PECS and sign language. The study found higher level of vocalizations for both participants of the study during mand training using manual signs with vocal prompts compared to training with PECS.

Schlosser and Wendt (2008) did a systematic review on the effect of AAC on speech production in persons with autism. Nine single subject studies published between 1975-2007 evaluated vocal production. Of the nine single subject studies one included manual signs, three included SGD and five included PECS. Aggregate results from these nine studies suggested two demonstrated improvements in vocals using PECS (Ganz et al., 2006; Tincani, Crozier, & Alazetta, 2006); one showed benefits in vocalization using an SGD (Olive et al., 2007); and one demonstrated vocal production using signs (Tincani, 2004). Two studies by Tincani (2004) and Tincani et al. (2006) produced contradictory results for the same intervention.

Ganz, Earles-Vollrath, Heath, Parker, Rispoli and Duran (2012) conducted a meta-analysis on 24 single case studies, which included 58 individuals with 64% having a diagnosis of autism. Nine studies involved PECS implementation, seven involved unstructured picture based AAC with varied instructions and eight had participants using SGDs. Except four all other studies investigated improvements in communication skills however none focused on effects on vocalizations.

Gevarter, Reilly, Rojeski, Sammarco, Lang, Lancioni and Sigafoos (2013) in their review identified 28 studies published between 2004 and 2012 conducted with people with developmental disabilities between 2 to 52 years of age using different AAC communication systems. They compared non-electronic picture systems and SGDs, PECS and SGDs with manual signs, and speech language interventions with AAC. Findings from these studies suggested learner characteristics played a significant role and a variety of AACs may be effective with children with ASD. Some studies with collateral vocal speech outcomes included (Beck et al., 2008; Curtis, 2012; Tincani, 2004) while inconclusive results on vocalization were observed by others (Boesch, 2011; Ganz et al., 2010).

Still, Rehfeldt, Whelan, May and Dymond (2014) conducted a systematic review across 16 studies (1998-2013) that included 46 participants below 16 years of age with a diagnosis of autism. The studies highlighted high-tech AACs were most commonly employed for communicating needs for preferred items like food and toys. Interventions demonstrated positive outcomes facilitating communication with the use of SGDs with the autism population.

A more recent systematic research on the role of AACs on children's with autism, was conducted by Iacono, Trembath and Erickson (2017). Reviews conducted across 17 selected studies (2000-2016) strongly supported teaching functional communication especially requesting (Ganz et al., 2012). There was strong evidence of efficacy when using PECS and SGDs while the evidence for using manual signs was weak.

Based on the results some conclusions could be drawn. Firstly, the hypothesis that AAC could obstruct natural speech production is not borne out by the studies as none of them reported any decline in speech production with AAC interventions compared to baseline levels. However the hypothesis cannot entirely be rejected as failures may not get reported or published.

H. Video-based Mand Training

Plavnik and Vitale (2016) studied vocal mand training strategies in four children with autism between ages 2 years 11 months to 3 years 6 months. Three children were non-vocal while one could imitate 8-10 words in routine situations. The dependent variable was the number of vocal mands acquired and mastered in an alternating treatment design. Intervention was conducted in-vivo (Sundberg & Partington, 1998) and through video-based mand training procedures (Nikopoulos & Keenan, 2004) after contriving establishing operations. During both conditions prompt fading was conducted using time-delay procedures after the child emitted a prompted mand. All participants acquired vocal mands during both interventions however the rate of acquisition was higher in video-based intervention. Only one of the four participants acquired equal mands during both conditions.

I. Intraverbal Training

One of the basic modes of intraverbal training occurs during rhyme fill-ins (Sundberg & Partington, 1998) or fun-fill-in. For e.g. Saying “go” in response to someone saying “ready, set, ___” would be a fun-fill-in while saying “star” when “twinkle, twinkle, little ___” is sung would be a rhyme fill-in.

Intraverbal training for children with autism has included teaching complex verbal behavior such as manding for answers to questions (Ingvarrson, 2010), emergent mands, tacts and intraverbals in a second language (May, Downs, Marchant & Dymond, 2016). While overall research under this operant has been limited (Aguirre & LeBlanc, 2016) there have been negligible studies that explored the possibility of increasing or inducing vocalization using intraverbal training.

7.3 Summary

This Chapter reviews various behavior analytic technologies involved with increasing vocalization in both vocal and non-vocal children. A review of various behavioral strategies used for emission of vocalizations suggests echoic training based on shaping was clearly ineffective (Stock et al., 2008) and was not feasible for implementation with non-vocal children with autism due to decreased happiness factor (Green & Reid, 1999, p.284). RMIA as a technology based on the principle of behavior momentum could be promising but needs further research. Few approaches such as NLP (Koegel et al., 1987), incidental teaching (Hart & Risley, 1975) focused on participant motivation and embedded teaching in natural environments using behavior principles for facilitating communication. Incidental teaching is used within mileu teaching where motivation is captured with time-delay prompts. Though considered as promising with efficacy for individuals with ASD, it is identified as being evidence based (Mulhern, Lydon, Healy, Mollaghan, Ramey, & Leoni, 2017). Randomized group studies (Yoder & Stone, 2006a; Yoder & Stone, 2006b) too have addressed milieu teaching and its components as demonstrating efficacy (Brunner & Seung, 2009).

Further studies on AACs suggested the overall effectiveness of unaided AAC (manual sign training) were substantiated by various meta-analyses (Goldstein, 2002; Mirenda, 2003; Schlosser & Lee, 2000; Scholsser & Sigafoos, 2006;). During detailed reviews of comparative studies involving unaided AACs; methodological concerns and threats to internal validity were noted (Mirenda, 2003). On the other hand aided AAC interventions using PECS may be considered moderately effective with emerging evidence (Curtis, 2012). Most studies on manual signs included comparisons with aided systems (Gervater et al., 2013; Hart & Banda, 2010; Lorah, Parnell, Whitby, and Hantula, 2014; Millar et al., 2006; Schlosser et al., 2008). With specific reference to manual signs most studies suggest teaching manual signs present challenges due to poor imitation skills and motor difficulties in children with autism (Ganz et al, 2002; Rose, Trembath, & Bloomberg, 2016). The authors conclude families should preferably adopt an eclectic approach as research in AAC has yet to demonstrate the promise of ongoing language development in children with autism and outcomes may be viewed with caution due to individual differences in participants with ASD.

The next Chapter enumerates experimental designs and reviews strengths and limitations of the various designs, which support scientific research necessary to valid inferences.

Chapter 8: Research Design

8.1 Overview of Research Design

Research in early 1900s in the field of experimental psychology was largely single subject. Investigations on perception (Wundt, 1932-1920), human memory and recall (Ebbinghaus, 1850-1909), respondent conditioning (Pavlov, 1849-1936) and learning (Thorndike, 1874-1949) were largely conducted on few subjects at a time. An analysis of publications in psychological journals up to the 1930s suggests that research with very small samples of one to five participants was clearly the rule (Robinson & Foster, 1979) and studies in clinical psychology explicitly focused on the idiographic approach i.e. the intensive study of the individual (Allport, 1961; Barlow & Nock, 2009).

However small sample size, the absence of controls within research (Dittmer, 1926) and the development of statistical methods brought a shift in research from smaller groups to larger sample size. The idiographic approach is in contrast to the nomothetic approach in which a relatively large group of individuals are selected and a straightforward independent variable is applied and observation on the average response of the group are compared to those on the control group (Barlow & Nock, 2009). In the last few decades, the nomothetic strategy became central to establishing both internal and external validity (Nock, Janice & Wedig, 2008). The idiographic and nomothetic approaches differ mainly due to the high level of variability between individuals where the researcher studies the influence of the independent variable over and above biological and environmental influences; and the generality of finding.

The advent of large sample size during clinical trials occurred due to funding of large scale randomized control trials especially in medicine. This included assigning large number of participants randomly to two groups. An experimental group which received treatment with certain drugs and a control group, which either received variants of treatment, no treatment or a placebo. Data obtained from the experiment were followed by a systematic statistical analysis from multiple randomized control trials (Guyatt, Oxman, Vist, Kunz, Falck-Ytter, et al., 2008). Subjects were assigned randomly to groups before experimental manipulations and the larger the sample size demonstrating statistical significance, the higher the generality and reliability (Kazdin, 2011) of experimental condition.

In the context of treatments, evidence based interventions (EBI) applies to a wide range of disciplines such as medicine, social work, speech and language to rehabilitation and well controlled research included both randomized controlled trials and single case experimental designs (Chambless & Ollendick, 2001). However, over time many psychologists and other social and health scientists started viewing randomized controlled trials (RCTs) as the gold standard for research in interventions (NICE, 2009) necessary for establishing its effectiveness. This had the effect that research strategies became dependent on one experimental paradigm for assessing if and how different medical, psychological, or educational procedures were effective or efficacious (Edward, Carr, Granpesheh, & Grosman, 2009).

The rationale behind all experimentation whether single case or between-groups is to identify variables affecting results so evidence based inferences can be drawn for effective interventions and accountability (Kazdin, 2011).

8.2 Randomized Controlled Trial (RCT)

Randomized controlled trials (RCT) are often considered gold-standards in intervention research mainly due to the fact that they involve working with large samples and include random assignment of participants to an experimental or a control group. Assigning participants randomly ensures groups are equivalent on critical variables like diagnosis and demographics as per pre-tests relevant to study to avoid selection bias. The differences obtained at the end of the study thus reflect the effect of intervention rather than pre-existing characteristics. Blinding/double-blinding assessments and treatment also makes conclusions robust (Keenan & Dillenburger, 2011). The American Psychological Association states that “Randomized controlled experiments are the most effective way to rule out threats to internal validity in a single experiment” (APA, 2002a) and outcomes may require replications, to overcome threats of external validity. Using large groups of subjects, leads to the assumption that when the number of participants is increased, the external validity of the findings increases. However, random assignment does not guarantee equivalence in groups at the beginning of treatment (Kazdin, 2001).

RCT studies have been conducted on ABA based studies such as, comparing behavioral interventions to eclectic approaches (Eikeseth, Smith, Jahr, & Eldevik, 2002), parent managed intensive intervention for children with autism (Bibby, Eikeseth, Martin, Mudford, & Reeves, 2002), however limitations of RCT goes beyond internal or external validity (Keenan & Dillenburger, 2011). Often outcomes can be misleading, as group averages do not apply to individual patients. The results of these calculations can lead to the assumption that correlations equate to causations (Keenan & Dillenburger, 2011). Also, data merged across studies through statistical metrics multiplies the problem of RCT as they calculate the mean average of various studies (Strain, Kohler, & Gresham, 1998). Group mean also hides the variability in the data that comes from an individual participant's results and thus may have a serious impact on the interpretation of results (Sidman, 1960). The focus of a treatment eventually is to benefit the individual patient, and not the group average. Difficulties are further complicated with respect to replicability in children with autism, which is a highly heterogeneous spectrum disorder that does not allow for matching of homogeneous samples. This leads to problems of internal as well as external validity. Keenan and Dillenburger (2011) conclude that group designs, such as RCTs, may provide information on populations but not on individual differences.

The central ethical guideline of human experimentation is the concept of equipoise (Ashcroft, 1999). Equipoise ethically applies to the enrollment of a participant in a randomized controlled trial only when substantial uncertainty exists as to which of the trial treatments would most likely benefit them. Clinically a patient can be randomly assigned to treatment if equipoise exists. This has serious implications (Morris, 2009) especially for young children with autism, who require early intervention and many proven evidence based interventions are available.

The fact that most ABA-based procedures, especially those used with young children with autism, have substantial evidence bases of clinical effectiveness, makes the use of RCTs in this field contrary to the principle of equipoise.

8.3 RCT and Clinical Decision Making

Clinical interventions are subject to high degree of accountability with respect to individual clients, due to the involvement of direct and indirect sources of funding agencies. To ensure outcomes are achieved, clinicians evaluate treatments on an ongoing basis, modify treatments based on learning of selected targets, and develop new intervention. All this is possible through continuous measurement. In a randomized controlled trial the performances of the groups are compared, and the effects of the intervention are evaluated at the end of the study. Clinical rigor demands that during the rehabilitation process interventions are evaluated, this is necessary to determine its timely effectiveness. An established treatment (via RCT) with demonstrated efficacy needs to be further evaluated to observe its benefits on particular patients as reported in literature. Perdices and Tate (2009) suggest that very often-different patients with similar impairments have different functional manifestations and require individualized treatments. The application of intervention X to treat problem Y in a cognitive, behavioral or sensory-motor impairment is not a simple solution. The clinician needs to be creative in selecting a treatment focused on the individual for a perceptible beneficial impact.

As the focus of behavioral sciences is the individual and not a group average, research in behavior analysis generally uses single-subject experimental designs (SSEDs). The scope and application of SSEDs has been extended in the field of applied behavior analysis to everyday life across a range of settings, intervention techniques, and individuals.

8.4 Single Subject Experimental Design (SSED)

In single subject experimental design (SSED), the effect of the intervention is evaluated by comparing different conditions presented to the same participant across time, i.e., intra-subject comparisons where the subject is its own control. The designs evaluate the effect of a given variable (Sidman, 1960) as replications across subjects. SSEDs are time-series designs that involve the study of the changes in behavior of one system, usually one individual, during baseline, i.e., before an intervention, during an intervention or various interventions, and after the intervention phase. Thus, SSED studies establish a functional relationship between the intervention and behavior change (Johnston & Pennypacker, 1993; Keenan & Dillenburger, 2011; Sulzer-Azaroff & Austin, 2000; Vegas, Jenson, & Kircher, 2007). Given that the aim of any behavior analytic intervention is to arrange the variables in a way that improves socially valid outcomes while at the same time reducing internal threats to validity such as effects of history (home environments), maturation, instrumentation (criterion changes made by observers), repeated testing and avoiding diffusion of treatment by keeping the interventions distinct.

8.5 Research in Autism Spectrum Disorder

The heterogeneity of individuals on the autism spectrum requires each intervention to be specifically tailored to meet individual needs. This needs direct and frequent data collection through repeated observations of targeted responses across a temporal dimension. A check on internal validity made through inter-observer agreement (IOA) ensures inconsistencies among observers are minimal. Inter-observer agreement confirms the behavior of interest is well defined and data is collected on the same behavior and repeated measures across observers over time minimize observer bias. IOA with high levels of agreements refer to the correspondence of data between observers. These make the SSED strong on internal validity. Replications of these experiments across participants and settings (Green, 2008), with variations in designs, like the multiple baseline designs, ensure external validity (Kazdin & Whitley, 2006). This enables the experimenter to understand the effect independent variable will have on behavior for future replication (Johnston & Pennypacker, 2009). While using a single subject design it is possible to study the stability of performance, trend and variability in baseline as well as during intervention. For example, a baseline, which shows an increasing trend, gives enough scope to the experimenter to wait for the trend to stabilize before intervention is started. Thus SSEDs provide a powerful research and clinical tool during interventions (Perdices & Tate, 2011).

8.6 A-B Design

In single-subject research an A-B design is usually considered the simplest design. It is a two-phase pre-experimental design consisting of a pre-treatment baseline condition

(A) followed by a treatment condition (B) (Cooper, Heron, & Heward, 2007). During the application of this design the dependent variable is repeatedly measured in the baseline (A) and the intervention (B) phases (Barlow, Nock, & Hersen, 2009). The logic behind an A-B design is that if the baseline is stable and an independent variable is applied, then the controlling factor for any change in the dependent variable, i.e., behavior observed during baseline is, because of the intervention i.e., manipulation of the independent variable (Dounavi & Dillenburger, 2013). It is important to note here that this assertion can only be true if,

a) All efforts are made to reduce the likelihood of other variables affecting the experiment
b) The independent variable is applied only when the baseline is stable
c) Repeated measures are taken on the dependent variable after the independent variable is applied
d) Verification can be demonstrated; if the independent variable was not used; baseline would have remained unchanged (Risely, 1969). These can be demonstrated by returning to baseline.
e) Replications of AB design studies that obtain similar outcomes strengthen the reliability of findings in previous experiments using the same independent variable for behavior change. This can be done through repeating the A-B design on different subjects, settings and/or behaviors (i.e., testing generality or external validity) by also varying the design, for example through an ABAB design or a multiple baseline design.

A-B designs contribute important and useful findings. Azrin and Wesolowski (1974) used an overcorrection procedure to reduce the stealing behavior of thirty-four adults of a residential unit with an average age of 41 years and IQ of 15. A within-subject experimental design was used. Baseline observations of thefts were 20 episodes per day when a simple correction procedure was used. Introduction of an over-correction procedure (independent variable) during thefts of edibles resulted in reduction of stealing behavior to nil within three days. Replication of an over-correction procedure across various studies (Duker & Seys, 1977; Singh & Winston, 1985; Wells, Forehand, Hickey & Green, 1977) have led to reduction in a variety of behaviors like vomiting, pica, and self stimulatory behaviors in persons with disabilities in peer reviewed literature substantiating external validity of the A-B design.

However any behavioral change after the introduction of the independent variable may be considered with a high degree of skepticism (Barlow et al., 2009) due to possible errors such as “false positive” and “false negative” (Bartlett, Rapp, & Henrickson, 2011). False positive refers to observed changes in the dependent variable when in reality no change occurred, while a false negative refers to missing out changes when in reality the change did occur.

A-B designs such as the reversal design, withdrawl design, concurrent and non-concurrent multiple baseline design have all been constructed from the core foundations of the A-B design. In case the A-B design produces high levels of false positives, multiple baseline designs may be an effective strategy (Krueger, Rapp, Ott, Lood & Novotny, 2012). Multiple baseline designs can be used for experimentation when withdrawl or reversal designs cannot be implemented and causality is determined by increasing the internal validity while ensuring behavior changes occur only after the introduction of the independent variable (Dounavi & Dillenburger, 2013).

Issues of false positive are addressed in group designs by the application of various statistical tests however single subject designs rely on visual analysis to determine if changes are due to the independent variable. Overall data represented through visual analysis in single subject designs have a high degree of internal validity (Horner, Swaminathan, Sugai, & Smolkowski, 2012). The objectivity of this data has also been evaluated in a number of studies (Brossart, Parker, Olson, & Mahadevan, 2006; Kahng, Chung, Gutshall, Pitts, Kao, & Girolami, 2010; Normand & Bailey, 2006; Vanselow, Thompson, & Karsina, 2011).

8.7 Multiple Baseline Design (MBL)

The multiple baseline design (MBL) was first introduced by Baer, Wolf and Risely in 1968, as an alternative to reversal design in applied research. It involves the study of several behaviors, settings or participants over time such that several baselines are established. The independent variable is applied one at a time while baseline data is recorded for the dependent variable. Experimental control is demonstrated when the independent variable is applied to one behavior, setting or participant at a time until a change is observed or criterion met. The same procedure is then applied to another behavior, setting or participant and so on and so forth. Instances where an intervention cannot be withdrawn such as during a self management strategy, academic learning or during vocal emergence, an MBL can be applied (Dounavi & Dilleburger, 2013). This design has been immensely popular in behavior analysis literature with nearly 24.7% articles published in *Behavioral Interventions* employing MBL (Carr, 2005).

In the MBL design across participants, the same behavior is observed across two or more participants. When a steady state of responding has been acquired in one participant during baseline, the independent variable, is applied to the first participant, while baseline conditions are maintained for the other participants. When criterion-level responding is attained in the first participant, the independent variable is applied to another participant and so on (Craft, Alber, & Heward, 1998; Kahng, Iwata, DeLeon, & Wallace, 2000; Kladopoulos & McComas, 2001). Multiple baselines across participants are widely used by teachers, clinicians and all those who provide services to clients where skills may be taught for example teaching naming (Fiorile & Greer, 2007), studying the efficacy of self determined learning model (Agran & Wehmeyer, 2000), social skills or reduction in motor stereotypy in children with autism.

In multiple baseline across behaviors, a single participant's two or more behaviors are measured, for example the behavior of stealing candy, hygiene products and jewelry (Carter, Holmstrom, Simpanen, & Melin, 1988). Under baseline conditions when a steady state of responding is obtained, the independent variable is applied to one behavior while the second behavior is maintained under baseline condition. Once criterion levels are reached for the first behavior the independent variable is applied to the second behavior (Gena, Krantz, McClannahan, & Poulson, 1996; Higgins, Williams, & McLaughlin, 2001). Results obtained illustrate in this single-subject experimental design, each subject is his own control.

The multiple baseline across settings is a design variation where a single behavior performed by a participant or group is studied across a variety of settings like a park, classroom or club. Baseline observations are made in all the settings and once data is stable, the intervention is applied in one setting while baseline conditions are continued in other settings. When behavior change is demonstrated in one setting, intervention is started in the second setting and so on.

Multiple baseline designs may be concurrent or nonconcurrent in which experimental control is based on evaluating behaviors across different baselines. In the concurrent MBL, each baseline is established contemporaneously such as the multiple probe design across participants (Horner & Baer, 1978) in which baseline data taking starts simultaneously while the independent variable is applied on participant one. Baseline observational probes are conducted intermittently, rather than continually for all other subjects except the first, to determine if their target behavior has changed prior to intervention. In the nonconcurrent MBL, the baseline data is not collected simultaneously for each participant or behavior. For example in the delayed MBL the baseline data is collect for the first participant and once stable data is obtained the independent variable is applied with the same participant. Subsequently baseline for the next participant is collected after the independent variable has been applied on previous subject and once criterion is met by the first participant, the independent variable is applied on the next participant and so on and so forth preferably two or three times (Barlow & Hersen, 1984).

Nonconcurrent MBLs such as delayed multiple baseline design provide a flexible alternative (Harvey, May, & Kennedy, 2004) and can be applied when a reversal design is not possible and practical difficulties, limited resources and ethical concerns do not allow a full-scale MBL. It is also recommended when a new behavior, setting, or subject becomes available (Heward, 1978). Delayed MBLs are recommended in educational settings (Harvey, et al., 2004) however it has been recommended that collecting more than three data points in phase A and ensuring stability in data paths in phase A would decrease the probability of false positives (Krueger et al., 2012). Also experimenter bias and threats to validity can be avoided if the hypothesis is specified and time-frames are selected apriori.(Christ, 2007).

The current study utilizes nonconcurrent multiple baseline design specifically delayed multiple baseline design across participants. Pre-baseline and baseline assessments on each participant suggested an absence of vocalization and each selected participant had no vocal-verbal repertoire at intake. Secondly, the dependent variable measured for speech or vocal acquisition as mands, echoic-mands, tacts or intraverbal fill-ins making the dependent variable robust. Thirdly the next participant was added only after the previous participant acquired a minimum of one vocal across a pre-defined mastery criteria or did not demonstrate a change in the dependent variable across minimum 12 weeks (Dounavi & Dillenburger, 2013). Fourthly the mastery criteria was across days and demonstrated stability rather than an immediate increase in vocalizations as in previous studies (Esch et al., 2009; Miguel et al., 2002; Sundberg, 1996). To achieve external validity each multiple baseline in the current research included minimum three participants and studied generalization effects across 13, 10 and 5 multiple baselines for. Experiment 1, 3 and 4 respectively and included 58, 3, 46 and 19 participants in Experiments 1, 2, 3, and 4 respectively.

8.8 Summary

This chapter outlined the rationale behind the current study in terms of methodology and concluded that single subject design methods, in particular delayed multiple baseline design were suitable to address the study questions. The following chapter outlines the details of the current research methodology.

Chapter 9: Overview

9.1 Research Aims

Few studies have examined the emergence of vocalization in non-vocal children with autism. Most studies in this field to-date have used behavioral technologies to improve vocalization in children with functional or non-functional speech (Shillingsburg, 2015) however none of these studies used a sample of entirely non-vocal children with autism (i.e., children who were mute or did not vocalize).

There is a significant variance in the definition of what is considered "vocal" in the literature. Terminology used to define non-vocal varied such as, non-vocal due to no functional speech (Esch et.al., 2009), being functionally mute (Laski et al., 1988), or non-vocal with limited spontaneous vocals (Normand et.al., 2006). As a result, many of the previous studies included children with pre-existing vocals (Charlop-Christy et al., 2002; Miguel et.al., 2002; Miliotis et.al., 2012; Petursdottir et. al., 2011; Roche et al., 2014). While some studies demonstrated improvements in vocalizations, most participants had some form of vocal repertoire already present.

9.2 Main Research Questions

The main research questions for the present study are:

- Can non-vocal children with ASD acquire speech?
- Which technologies play a role in evoking vocals?
- Does acquisition of manual signs support vocalization?
- Is age an important factor in acquiring vocals?

The aims of the present research were

1. To define what constitutes being vocal;
2. To develop specific behavior analytic strategies and assess their effects on the evocation of vocals in non-vocal children with autism;
3. To achieve maintenance effects in acquisition of vocals;

4. To establish replication effects across a large cohort of children with autism;
5. To ensure social validity, i.e., the social significance of the goals, the social appropriateness of the procedures, and the social importance of the effects.

9.3 Research Objectives

The objectives of this research were:

1. To review the literature and provide an operational definition of vocalization and what can be considered mastery criteria in relation to vocalizations;
2. To develop procedures and study the effect of teaching communication using manual signs paired with vocal stimuli, to non-vocal children with ASD under conditions of motivating operation;
3. To assess experimental control over speech evocation using various multiple baseline studies;
4. To explore age difference effects in communication and speech emergence for non-vocal ASD children under the age of three years compared to those who are aged eight years and above;
5. If vocals do not emerge after approx 12 weeks with the procedures implemented, to explore the effect of adding a second treatment (i.e., intraverbal training using stimulus-stimulus-pairing) as part of an intervention package;
6. To explore the effect of delayed prompting in evocation of speech;
7. To identify the variables, if any, which effect the rate of vocal evocation.

9.4 Ethics

The ethics committee of Queen’s University Belfast approved this research project. Research participants were children with a diagnosis of autism living in India across various states who were enrolled at a particular intervention facility. Informed consent was obtained from the parent/caregiver of each individual participant listed in Table 12 (Appendix 2). QUB research governance and data protection procedures were adhered to.

9.5 Intervention Centers

The target population was enrolled in one of seven autism intervention centres owned and run by the same umbrella organization (a private company) in India, located in Bangalore (3 centres), Delhi, Noida, Mumbai, and Hyderabad. All intervention centers across all cities were similar in structure, administration and functioning. Each intervention center had an administrator who took enquiry and admission calls, fixed assessment dates with families seeking intervention, completed admission formalities and managed regular staff who worked from 9am – 5pm. Parents/guardians of children with a diagnosis of ASD and other special needs were referred to the intervention centers by developmental pediatricians, family doctors, other referral agents, or self-referral, through internet searches. Each parent/guardian visited the center, and met the local administration of the center, and decided to seek intervention.

All seven centres provided services based on Applied Behavior Analysis (Baer, Wolf and Risley, 1968) and Verbal Behavior (Skinner, 1957). Interventions at the centres were conducted in a one teacher to one child ratio between 9am and 5pm, Monday to Friday. All centres were closed for two weeks (a fortnight in May and fortnight in December) during which period no interventions were conducted. Each intervention center was housed in an independent rented villa located in a securely fenced compound. Each compound included an outdoor play space for children to skate, use the scooty, and bicycles. Inside the villas, the rooms had tables, chairs, and shelves for each individual child, and the common play park area had play equipment like swings, merry-go-round, slide, seesaw, and a large trampoline. Each room could accommodate 4-6 students, where everyone was in view of others. There were no partitions separating the tables. Each center had a CCTV placed to cover each room and the play park area and was monitored by the administration personnel. The tables, chairs, and shelves could be moved between the play area and the classrooms as per the specific programme designed to meet the child's needs. A child who had difficulty in transitioning from the play area could have his table close to the trampoline initially and gradually moved into the classroom. Shelves provided for children were organized by the therapist, with teaching materials, cards, puzzles and toys specific to the child's needs arranged before each session. Baskets of toys were kept in a cupboard from which therapists selected child specific toys before each session.

All therapists employed in the centres wore a waist belt in which they kept edible reinforcers in sandwich bags for easy access when they were training in the natural environment and were out of seat. A typical day started with preference assessment, non-contingent pairing, and manding.

After making initial enquiries about enrollment and fee; the parents/guardians registered their child for 1:1 intensive behavioral intervention at one of the centres. Once the parent/guardians completed the admission formalities, including paying the monthly fee and signing all documents, their child was considered enrolled. Each intervention center provided therapy for 10-40 individuals between ages 1.4 years to 27 years of age. Participants attended the center for 5 days/week. On admission, non-vocal participants with a diagnosis of ASD, were referred to the researcher.

9.6 Staff

There were three levels of personnel involved in the study. i) Board Certified Behavior Analysts (BCBA) ii) supervisors and iii) therapists.

9.6.1 Behavior Analysts

The Board Certified Behavior Analysts (BCBA) were trained in applied behavior analysis to Masters level and certified by the Behavior Analyst Certification Board (BACB). The BCBA was involved in staff training, supervision and monitoring, treatment integrity checks, inter observer agreement and data reviews. There were two BCBAs involved in the study, including the present researcher.

9.6.2 Supervisors

Criterion for supervisor selection was a minimum two years of hands on working experience in 1:1 intervention with children with autism using ABA-based procedures of which at least six months had been spent in supervising therapists. Selection was made based on direct observations during staff training and applied knowledge in verbal operants, motivating operations, preference assessment, manding, prompting, prompt-fading, using reinforcers effectively (contingently, immediately, using the right size), and data taking.

A total of seventeen supervisors participated in the study over the entire period of six years of whom four left midway; eleven supervisors were students of applied behavior analysis mentoring under a BCBA while the remaining six were trained in-house in the intervention center. Six supervisors were postgraduates, and eleven were graduates. The supervisors were assigned the role of staff training, and were trained for conducting treatment integrity checks, and inter-observer agreement (IOA) by the researcher.

9.6.3 Therapists

The therapists involved in the research were employed by the umbrella organization. The organization had completed a background check on individual applicants before a letter of appointment was issued. Each selected therapist signed an ethical compliance form (Form 4, Appendix 1) indicating acceptance of the organization's ethical guidelines and included safe handling of children, maintaining confidentiality and being honest in reporting. These were in the custody of the administrator of the organization.

The criteria of selecting therapists for participating in this research from the pool of therapists working in the organization were: having a minimum educational background of Grade XII (equivalent to A-Level in U.K.), graduation or post-graduation from any branch of study, an initial didactic training of 40 hours conducted by an ABA educated supervisor covering a syllabus which consisted of symptoms of autism, verbal operants, preference assessment, delivering reinforcers, prompting strategies, contriving motivating operations and data collection; and having a pleasant demeanor with ability to play with children. During the selection of therapists the researcher ensured there was no discrimination by age, sex, gender, or education, no extra remuneration was provided and there was no implication for not participating. Therapists who were willing to be part of the research were shortlisted for training.

There were 50 therapists shortlisted for participating in this study across the 7 centers. 83% of therapists were graduates in any field of study, 12% were post-graduates, and 5% were Grade XII. At any point in time two therapists were trained to work with one participant. This ensured the participant continued with intervention in case of absenteeism or other eventualities, like staff attrition. As the research continued between the years 2010 – 2016, some therapists left the organization due to personal reasons. In such case another therapist was assigned to the participant to continue treatment.

The therapist's role was to work directly with the child. Each therapist worked for two-hour sessions each day, focusing on intervention. Therapists were responsible for doing the preference assessment, following the treatment intervention plan, taking data on clickers, transferring the data on relevant data sheets, and reporting deviance like low motivation or any behaviors to the supervisor for guidance. Each therapist was provided intensive training before working with assigned participants and supervised as per plan given below.

9.7 Data Taking and Record Keeping

A clipboard with data sheets and a pen was used for taking data. Each therapist was provided with two data collection clickers and a timer. Data collection clickers were used for taking frequency data. For ease of access to the clickers, these were either tied to trousers or belts or hung around necks. The two clickers were used to take a variety of frequency data like prompted and unprompted trial data or mand and S^D data or behavior data. Timers were used for taking duration data during free operant preference assessment.

Data for each child were kept in a ring binder in which the program and its revisions were recorded and filed. It included skill-tracking sheets (Form 13, 14, Appendix 1) assigned to various domain areas, probe data sheets (Form 15, Appendix 1), and all other information relevant to the child's demographic background and learning history. The binders were confidential and stored in a locked cupboard under administration supervision. Parents could access their children's binders during observation days with administration permission.

The researcher maintained records by transferring manual data on excel sheets on a computer for each student, rechecked by another available person. Excel sheets were maintained for each experiment. This included each participant's demographics, start date on the experiment, vocal emergence details, treatment integrity scores during the first week of intervention and monthly checks and inter-observer agreement scores.

9.8 Participants

A total N=144 non-vocal children joined the intervention center between March 2010-September 2015 and were referred for evaluation. The last date for entry into the study was September 30, 2015 to allow for at least a year of intervention before data could be included in the study. Final data were collected by November 2016.

9.8.1 Inclusion and Exclusion Criteria

Inclusion was based on two criteria a) a diagnosis of being on the autism spectrum and b) being non-vocal. Non-vocal was defined as an inability to produce syllables, phonemes, sounds or words during assessments conducted under motivating operations. Children meeting inclusion criteria were included irrespective of age, gender, socio-economic or cultural background. Exclusion criteria were having another disability, other than autism and the presence of any vocal phoneme, syllable, approximation as a mand, tact, echoic, or intraverbal fill-in.

Children who attended one of the centres, but were excluded from the study continued to receive ABA-based intervention provided by the organization. For example MS a 6 year-old child with Down's syndrome joined as a non-vocal child at the Bangalore center and did not meet the inclusion criteria for the present study however he continued on the intensive behavioral intervention of ten hours/week for two years and acquired skills across eight domain areas, including acquisition of vocal communication using two words. Similarly VM, joined the Delhi center in 2011 at the age of ten years as a non-vocal child with a diagnoses of global developmental delays and did not meet the criteria for being on the study. He received 25-hours/week of intervention for five years, remained non-vocal but acquired many language, imitation, play and adaptive skills along with communication through signs. Those excluded from the study (Table 5) were not counted in the final participant sample however their demographic details are present in Table 12 (Appendix 2).

Parents/guardians of children who met the inclusion criteria for the study were presented a printed copy of an information sheet and consent form, that included an outline of the purpose of the research project and the methods, as well as a statement about the right to withdraw from the study without prejudice (Form 1, Appendix 1). Details of the researcher were provided and parents were encouraged to contact the researcher to address any queries. All of the guardians were parents (mother and/or father) of non-vocal children with autism and all provided consent for their child to participate in the research. Non-vocal participants had to spend a minimum 6 months on the study to be included in the final sample.

9.8.2 Participant Demographic Details

A total of N=144 participants were referred of which 18 were excluded to arrive at N=126 participants who met criterion for the study. 18 non-vocal participants excluded from the research were those with no clear diagnosis, a diagnosis other than autism spectrum disorder, not submitting the diagnosis report, and those who left the study midway before 6 months. Details of participants are provided below (Table 1).

Table 1: Total Enrollments

Total Sample	GDD	No Diagnosis	No Reports	Left within 6 months	Met Criteria
144	1	4	2	11	126

Participants N=126 included in the research were between the ages of 1 year 4 months and 13 years 5 months. Table 2 below, shows their distribution by age and gender

Table 2: Participants By Age

Age in Years	Number	% of Total
1.4 – 3.0	41	33%
3.1 – 8.0	79	63%
8.1 – 12	4	3%
12.1 – 13.5	2	2%
Total	126	100 %

The study included 33% toddlers and infants below the age of 3 years; with the maximum number of participants 63% between the ages of 3.1 and 8 years; 4% participants were between 8-12 years of age; while 2% of the sample was above 12 years. All children below the ages of 3 years were seeking intervention for the first time, and older children, e.g., Ann at 12.2 years and Dako at 13.5 years had been receiving interventions for many years. Males represented 82% of the sample while 18% were females. The predominance of males in this study is incidental and corroborates with the global ratio of 4:1 males to females, diagnosed with autism spectrum disorder (Fombonne, 1999).

Table 3: Participants By Gender

Total Participants		
Male	103	82%
Female	23	18%

Participants attended one of the seven centres located at various cities in India under the jurisdiction of the same organization; 44% participants attended centres in Bangalore while 14%, 14%, 18%, and 10% participants were selected for the intervention at Delhi, Noida, Mumbai and Hyderabad, respectively.

Table 4: Participants by Center Location

Bangalore			Delhi	Noida	Mumbai	Hyderabad	Total
HRBR	Sharjapur	Jaynagar					
31	19	6	17	18	23	12	126
44%			14%	14%	18%	10%	100%

Participants' families had a variety of mother tongues, including Hindi, Marathi, Gujarati, Kannada, Tamil, and Urdu however all had requested for the communication training program to be conducted in the English language except a few being taught mands in Hindi and Kannada.

State and Central government apathy in India towards support for evidence-based interventions led to parents taking the burden of intervention costs. The private nature of the intervention centres, despite providing services at 50% of the per hour market rate, made the services expensive for those seeking intensive intervention of 25 hours/week. Although most families did not disclose their income bracket, observations made from parents occupations (e.g., father working in IT industry), and their life style, it may be deduced that approximately 90% participants belonged to families from a higher socio-economic status.

As per ethical practice confidentiality was maintained for each participant throughout the study. Each participant was provided a random unique code name (Table 12, Appendix 2) and any reference in the present text relies on code names in the graphs, tables and results. Names were however retained on the binder that was kept under lock and key at each intervention centre and also on excel sheets with the researcher. No child or parent/guardian was related to the researcher and there was no conflict of interest. A master list (Table 12, Appendix 2) with details of each participants code name, age at intake, gender, diagnosis, center name, inclusion status, MBL assigned, vocal emergence status, vocals emerged, has been included for reference.

9.8.3 Participants' Selection

The selection of participants included a two-step process; a) screening the medical diagnosis of autism spectrum disorder and b) confirming the non-vocal status of the participant through an assessment.

Children with a diagnoses of Down's syndrome or Global Developmental Delays (GDD) despite being non-vocal were excluded from the study. Participants with a diagnosis of autism spectrum disorder were selected by reviewing reports provided by the medical diagnostician, such as a developmental pediatrician or psychiatrist and they were shortlisted for the study. A small number of very young children (below the age of 3 years of age) had not yet been provided with a clear diagnosis but were placed 'at risk of autism'; these children were included in the study if they showed symptoms as per the criteria provided in DSM-IV (Diagnostic Statistical Manual, 4th Edition). Time spent during this process varied between 1-1.5 hours/participant. No other attempts were made to assess the severity of the diagnosis.

Once diagnosis was confirmed, the admission assessment was reviewed and the Behavioral Language Assessment (BLA; Sundberg & Partington, 1998) was conducted to assess verbal repertoires of language-delayed children. The rationale for selection of BLA was due its ability to measure language and other skills across twelve domain areas such as cooperation, making requests, labeling, filling-in, making conversations, vocal play, visual performance, motor and vocal imitation, receptive responding including function, feature and class, letters and numbers and social interactions (BLA Form 5, Appendix 1). The assessment was comprehensive and provided opportunities to assess vocal-verbal behavior of the participants across verbal operants such as mands, tacts, echoics and intraverbals with or without manual signs or vocals. It also assessed vocal play such as babbling or other spontaneous vocalizations which served the purpose of the current research. Vocalizations on each domain area were assessed on five levels and could provided innumerable instances for participant vocalizations. The BLA also assessed in detail receptive language skills on FFC's and imitation. Scores ranged from a minimum 12 to 60. Participants were classified as Level 1 to 5. Those at Level 1 had a low verbal repertoire and participants at Level 5 had high verbal repertoire with a score of up to a maximum 60.

Once the non-vocal status of the participant was confirmed on BLA, each participant was administered the EESA sub-test (Form F6, Appendix) from the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP). The VB-MAPP (Sundberg, 2008) is a language assessment, norm referenced to the language and developmental milestones of typical children up to 48 months. EESA or the Early Echoic Skills Assessment developed by Barbara Esch, a speech and language pathologist and a behavior analyst, measures the ability to vocalize speech sounds and includes 5 different sub-sections or groups. Each sub-section assessed the level of echoic response. Group 1 included twenty-five simple and reduplicated syllables e.g. ‘ah’, ‘papa’ ‘moo’. Group 5 assessed pitch, loudness and duration of speech prosody. Only Group 1 on EESA was administered on participants to confirm their non-vocal status over two days. Because echoic assessments can evoke escape related behaviors or emotional responses the echoic trials were done with a lot of play breaks. A score of nil out of a maximum of twenty-five on Group 1 was required for enrollment on the research.

The purpose of these assessments was to confirm the non-vocal status of the participant. The BLA and EESA both indicated the vocal or non-vocal status of the participants. The assessment revealed if the participants' could echo any syllable, phoneme or word; fill in an incomplete rhyme such as "Johnny, Johnny, yes___(papa)", or an incomplete sentence such as "your name is___"; vocally label items when asked, "what is this?" or request using vocals. Children who were not able to echo/mand/tact/fill-in based on these assessments or acquired a score of "nil" on the tests on the vocalization criteria were included in the study. Any children with a verbal repertoire of 1- 2 syllables or words, even if inconsistent, were excluded from the study.

9.9 Timeline of Study

The study was initiated in March 2010. Non-vocal participants were identified, shortlisted and included as they became available for intervention. The year-wise admission of non-vocal participants is provided in Table 5 below. Intake of participants on the delayed multiple-baseline was halted in October 2015 while data collection was continued till November 2016. The timeline of the research was 6 years and 8 months.

Table 5: Yearly Enrollments

Year	2010	2011	2012	2013	2014	2015
Participants Included (126)	8	24	29	28	18	19
Participants Excluded (18)	0	2	0	7	4	5

9.10 Method Overview

Standard procedures were followed across all experiments for assessments, participant selection, staff training, defining and measuring vocalization behaviors, preference assessments, target selection, assigning to experiments and specific MBL studies, baseline procedures, conducting probes, treatment integrity checks, IOA, mastery criteria, and close of study. An overview of the methodology is discussed in the following section.

9.11 Standard Staff Training Procedures and Evaluation

The study was initiated by conducting staff training. The BCBA (researcher) trained, supervised and monitored the other BCBA, supervisors and therapists and reviewed participants' progress in all locations. Each therapist underwent didactic training of 20 hours conducted by the behavior analyst (BCBA) and supervisors. Training was conducted in the classroom and the natural environment and included lectures, role-plays, videos demonstration and practice under supervision. Training covered competency in the following areas: a) verbal operants – mand, tact, intraverbal, echoic b) preference assessment c) capturing motivation d) contriving situations for teaching mands e) delivering consequences f) prompting methods and g) data taking (Form 3, Appendix 1). Therapists were provided intervention in English and Hindi language and conducted intervention in English or Hindi (Indian language) as per parent request. At the conclusion of training the selected therapists were proficient in making distinctions between mands, tacts, echoics and intraverbals. They could demonstrate teaching trials on all the four operants. They were able to conduct a free operant preference assessment in natural environment as well the MSWO on the tabletop. During role-plays they could demonstrate methods of ascertaining motivation and contriving situations to build motivation in the event of the participant not demonstrating any e.g. closing a door to teach "open" mand. Therapists were able to record prompted and unprompted frequency data clickers, administer probe trials with delays of 3 seconds once a day on target trials and report vocal emergence once participant achieved mastery criteria. Competency checks were conducted post-training and a score of 80% before intervention ensured trainer selection.

The selected therapists were further trained on implementing the independent variables i.e. sign-mand protocol with stimulus-stimulus pairing, with and without time delays as well as the intraverbal training protocols. Evaluations were made prior to intervention, during which the researcher conducted checks on implementation of the independent variable (Forms 8.1-8.3, Appendix 1) in role-play situations. The therapists had to achieve a score of 90% before they were allowed to work with children. Retraining was provided if the score was below 90%. While 91% therapists were approved for intervention, 9% of therapists required retraining. All data was discarded once the selection process was complete.

9.12 Setting

The sessions were conducted in a 1: 1 format with one therapist assigned to a participant. The intervention was conducted in three different areas; the classroom, play area, and the computer area. The classroom was furnished with tables, chairs and shelves. The participants sat at an assigned seat and had pre-selected favourite toys and edibles kept in view for the child to demonstrate motivation for items. The classroom had three to four other 1:1 interventions going on simultaneously. The play park area contained play equipment's like the swing, seesaw, trampoline, slide and merry-go-round. All play park equipment was within reach and freely accessible for the participant to choose from. The third area was the computer area, located in a common space at the center where the computer station was fixed. It had pre-loaded Indian songs and dances and rhymes. The intervention was embedded within the regular therapy session conducted by the therapists.

9.13 Assigning Participants to Experiments

Each non-vocal participant identified for the study, was randomly assigned to Experiment 1 (2010-16), and Experiment 4 (2012-16) based on his or her date of joining and selection criterion. As the participants became available, they were assigned to the delayed multiple baselines (Heward, 1978) based on a previous participant acquiring more than one vocal on that MBL. If a previous participant did not acquire vocals for approximately 12 weeks, either another participant was added to the experiment while the previous continued with intervention, or a new MBL was initiated. Each MBL had between 3-8 participants. Out of N=126 selected participants, all except 4 were assigned to an MBL. The intervention continued with these 4 participants as single subjects. Details of participants enrolled on each experiment and the number of multiple baseline studies per experiment are listed in Table 6 below.

Table 6: Participants Assignment to Experiments

Experiments	MBLs/Experiment	Total Participants
Experiment 1	13 MBL's + 2 SS*	58
Experiment 2	1 MBL	3
Experiment 3	10 MBL's + 2 SS*	46
Experiment 4	5 MBL's	19

*SS= Single Subjects

Three participants were shortlisted randomly for participating on Experiment 2, as none of these had acquired vocals after mand training. Experiment 3 was initiated in 2011, as some participants had been on mand training with SSP without much change in their non-vocal status. 4 participants (AMEH, AKE, NPR & RKA) could not be included on any MBL as previous participants on the MBL had not achieved criterion and due to ethical considerations communication training could not be refused. Participants NPR, and RKA (Table 12, Appendix 2) were on Experiment 1 while participants AMEH, and AKE (Table 12, Appendix 2) were on Experiment 3. All four were on an A-B design and continued with intervention as single subjects.

9.14 Preference Assessment and Target Selection

Each experiment started with a preference assessment during which a free operant preference assessment (Roane et al., 1998) was made in natural environment and a multiple stimulus without replacement procedure (DeLeon & Iwata, 1996) was used at the tabletop. Items of high value 8-15, were identified from a list of toys, edibles, play park and computer; from which mand targets were selected. In studies where intraverbal training was introduced, targets were pre-selected across rhymes, fun-fill-ins and animal sound fill-ins. The targets were selected randomly and the only criteria applied for selection of these targets was they should be culturally common rather than unique. Such as "twinkle twinkle little star" is a much more common rhyme in India then "Pat a cake". For participants with limited preferences action mands were selected after contriving situation.

9.15 Dependent Variables and Response Measurement (All Studies)

Vocal Behavior is defined as the production of auditory stimuli resulting from the movements of the muscles of the vocal apparatus (Carbone, 2012). The dependent variable measured in the study was speech/vocal emergence of the first 7 topographically distinct vocals in the form of syllables, phonemes, word approximations or words acquired as per mastery criteria under motivating operation as a mand, or in response to a verbal stimulus as an echoic-mand, an echoic, tact or an intraverbal fill-in. Speech in the form of grunting, crying, giggling or babbling were excluded.

A specific vocal was defined as a syllable, speech sound, word approximation or word emitted by the participant in context as a part of the word paired or modeled. Examples of part of the modeled word could be saying ‘bu’ or ‘bis’ or ‘bikut’ for biscuit, or vocalizing ‘ee’ or ‘chee’ or ‘chipa’ for ‘chips’, ‘tu’ or ‘oy’ for ‘toy’ and so on. Non-examples would be saying ‘bu’ for ‘toy’ or ‘ee’ for ‘jump’. During training provided under motivating operation, a participant could emit a vocal independently or echo a vocal or part vocal after the therapist provided a verbal stimulus. This would be recorded as an instance of vocal echoic-mand. A vocal mand was recorded as having occurred only when it was unprompted. An unprompted vocal or its approximation emitted to fill the last word of an “antecedent verbal unit”, during intraverbal training would be recorded as vocal emitted as intraverbal fill-in.

Vocalization was achieved when it occurred under relevant motivating operation with the item in sight or out of sight. Specific vocals under echoic-mand were considered acquired when the word modeled by an adult was followed by a specific sound emitted by the participant during mand trials, which corresponded to part of the vocal modeled during training. Specific vocals, which emerged when the participant filled a word or syllable in a rhyme or fun statement, were the intraverbal operant. Examples of the intraverbal operant include saying ‘lane’ when presented with ‘ba-ba black sheep have you any wool…..’ or saying “thee”, “three” or “ee” when the therapist said “1, 2 __ (three)”.

9.16 Mastery Criterion

Vocalization was deemed as achieved with the emergence of n=7 specific vocals. A vocal met mastery criterion, when it occurred on the first trial of the day, consistently across 5 consecutive sessions, followed by 80% agreement across two observers. An example of a specific distinct vocal would be, /ba/ and /bo/; /apu/ and /apple/; or /o/ and /opu/. A non-example would be indiscriminable sounds such as /ba/ and /bae/. To ensure vocal emergence was consistent, varied, and under stimulus control, it was necessary to set the mastery criterion at a level which indicated stability and hence the mastery criterion was set for 7 targets. Vocals could be independent or repeated after the model during pairing. Participants who emerged with <n=7 vocals, or did not achieve mastery, continued on the intervention till the end of the study.

9.17 Behavioral Measurements of Vocalization

Emergence of vocals was measured in each experiment during Baseline probes and Intervention probes. Baseline probes were conducted thrice on each of the target items on mands, echoic, tact and intraverbal (Form 7, Appendix 1) probes. Once intervention was initiated, daily first trial probes were taken by the therapist for all target trials by withholding the vocal model for 3 seconds and recording any vocal emergence on the probe data sheet (Form F15, Appendix 1) as Yes/No data. A specific vocal emerged on the first probe of the day on 5 consecutive days, led to two observers, under the relevant operant condition and settings, conducting five further probes. An 80% IOA on vocal emergence and confirmation triggered an acquisition probe (Form 12, Appendix 1) across echoic, tact and intraverbal operants.

The supervisor and therapist, collected IOA data on separate probe data sheets (Form 12, Appendix 1) while the therapist interacted with the child, the supervisor stood 4-6 feet away and took simultaneous data independently on the vocal emergence and type of emergence. IOA was calculated using the formula:

$$\frac{\text{Total number of agreements}}{\text{Total number of probes}} \times 100$$

The therapist transcribed any vocal emergence as a syllable, phoneme or vocal approximation. In instances of disagreement on the type of vocalization (e.g. dee vs dat) the data were noted however IOA was repeated a week later. The vocal was considered acquired only when minimum 80% agreement was observed. IOA probes were not conducted for children who did not acquire consistent responding for 5 consecutive days. Thus IOA data were collected for each participant on a) baseline probes, b) confirmation of vocal acquisition (i.e. post 5 consecutive vocals) and c) acquisition probes (Form 12, Appendix 1) after each vocal. The mean IOA for the study was 91% (Range 76%-98%). IOA for each experiment is presented in Table 19 (Appendix 2).

9.18 Integrity of the Independent Variable

Treatment Integrity checks were conducted across all experiments involving the independent variables i.e. mand protocols, (Form 11.1A, 11.1B, Appendix 1) time-delay, (Form 11.2A, 11.2B, Appendix 1) and intraverbal fill-in (Form 11.3A, 11.3B, Appendix 1). The therapist/ instructor was observed on each component of the independent variable specific to the particular experiment. There were three independent variables on which the therapist was observed a) implementation of the mand protocol b) the time-delay mand protocol and c) the intraverbal training. The number of treatment integrity checks for each independent variable is enumerated (Table 7) below.

During the first week of intervention across two independent variables (a & b) across all experiments, the researcher or supervisor made observations on 50% trials for ensuring treatment integrity. Observations were made for 100 trials/week in the first week. A score of less than 80% led to pausing the intervention and re-training the therapist till a score of greater or equal to 80% could be obtained in role-plays and the intervention was resumed. Thereafter treatment integrity checks were conducted for one trial/target/participant/month that aggregated to 6 trials/month for a) and b). Treatment integrity checks were made each month till the last month of the participant being on the intervention.

Table 7: Treatment Integrity Checks – All Independent Variables

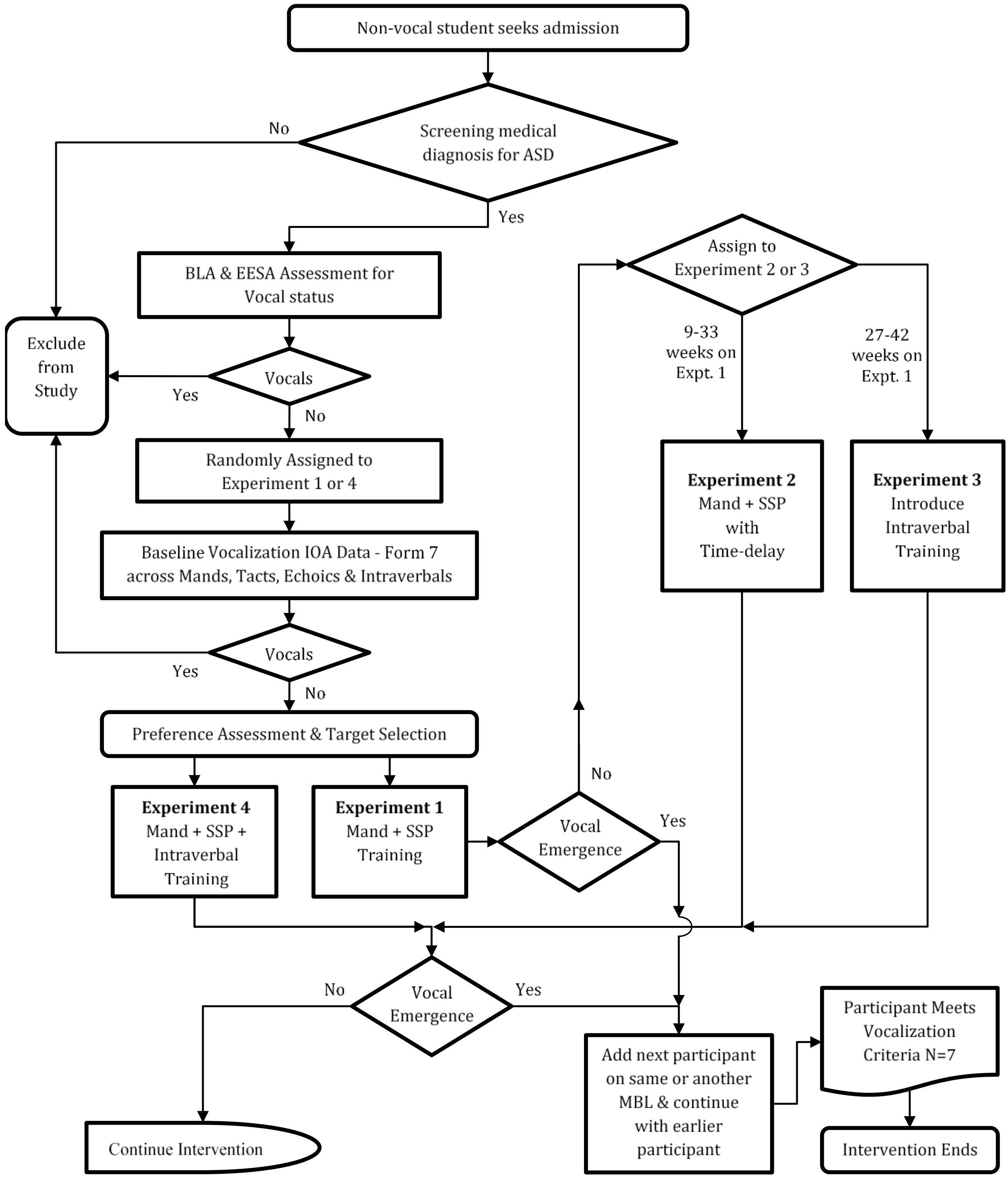
Independent Variable	Obs. Week 1	Obs. Once/Month
a. Mand Protocol	100	6
b. Time-Delay Mand Protocol	100	6
c. Intraverbal Training	50	3

Treatment integrity checks for the third independent variable (c) introduced on experiments 3 & 4 included the researcher/supervisor making observations on 50% trials during the first week and a score of less than 80% led to retraining. Thereafter treatment integrity checks were conducted for one trial/target/participant/month for each component of the independent variable. This aggregated to observing 50 trials/month in the first week and 3 trials/month subsequently. Treatment integrity scores obtained on forms (11.1-11.3 A & B, Appendix 1) were transferred on a weekly basis on the excel-sheet for ease of computation; and maintained by the researcher. Once data were transferred the manual papers were destroyed. Treatment integrity scores from each experiment are presented in Table 18 (Appendix 2) for reference. The mean treatment integrity score for the study (Table 18, Appendix 2) was 87% (Range 69% - 98%).

9.19 Summary

This chapter outlined an overview of the methodology and provided a macro view of the complete study across N=126 participants. It described in detail the common aspects across the four experiments conducted in the current study. The following chapter provides details on each of the four experiments and their conclusions.

Flow Diagram 1: <u>Participant Inclusion & Assignment on Experiments</u>



Chapter 10: Experiments

The current study included 4 experiments

1. The role of stimulus-stimulus pairing during sign mand training and its effect on the emergence of vocals in non-vocal children with autism.
2. The effect of time-delay during sign mand training with SSP on vocal emergence in non-vocal children with autism.
3. The role of intraverbal training with paired stimulus in inducing first instances of speech in non-vocal children with autism as an additional variable when stimulus-stimulus pairing during mand training is ineffective.
4. The effect of a treatment package including sign mand training with SSP and intraverbal training with paired stimulus on non-vocal children with autism.

Introduction Experiment 1

Title: The role of stimulus-stimulus pairing during sign mand training and its effect on the emergence of vocals in non-vocal children with autism.

Several behavioral interventions have been successful in increasing vocalizations in children with autism. The current study was conducted with 58 participants. Each participant was assigned to one of 13 multiple baseline studies based on their availability with consent and selection criterion while 2 participants were on single-subject design. Each participant was added to the MBL as the previous participant exhibited stable progress on the delayed multiple baseline. One delayed multiple baseline study (MBL 1.0) is described in detail below. The remaining MBL graphs are presented in Appendix 3 (Figures 1.1-1.13) serve as replications and an analysis from the findings are presented in discussions. The study described here includes five non-vocal participants between the ages of 2.8 years and 13.5 years who underwent mand training with stimulus-stimulus pairing. Four participants acquired first instances of speech as per criterion. Acquisition or non-acquisition of vocalization across participants is discussed based on individual differences.

Introduction Experiment 2

Title: The effect of prompt-delays during sign mand training on vocal emergence in non-vocal children with autism.

In the current study, three non-vocal, non-verbal children with autism aged 5, 4 and 5 years, underwent sign mand training for 9-33 weeks with paired vocal stimuli. In the absence of vocal emission, a delayed vocal stimulus presentation method was introduced (Carbone et al., 2010) across participants to test if that would be more effective in inducing vocalization. A combination of concurrent and delayed multiple baseline across participants' design was used. All participants acquired 7 first instances of speech as targeted and with continued training in follow up phase they acquired additional novel vocals. The findings provide evidence that mand training with delayed vocal stimulus presentation can be effective in evoking vocals in some children with autism.

Introduction Experiment 3

Title: The role of intraverbal training with paired stimulus in inducing first instances of speech in non-vocal children with autism when stimulus-stimulus pairing during mand training is ineffective.

Behavioral research on the intraverbal operant has focused on increasing existing verbal repertoire of children in the autism population with no research on its value for non-vocal children. Intraverbal training with rhyme fill-ins, fun fill-ins and contextual fill-ins can create opportunities for vocals to be emitted under the control of specific verbal stimuli (Coon & Miguel, 2012; Finkel, Williams, 2002; Grannan & Rehfeldt, 2012; Ingvarsson & Hollobaugh, 2011; Valentino, Shillingsburg & Call, 2012).

The current study is a novel experiment conducted with 46 non-vocal participants with a diagnosis of autism. Each participant was assigned to one of the 9 multiple baseline studies except two who were on single subject design based on their availability with consent and selection criterion. One delayed multiple baseline study (MBL 3.0) is discussed in detail below. The remaining graphs are presented in Appendix 3 (Figures 3.1-3.10) serve as replications and their findings are discussed in discussions.

The study described here includes 5 non-vocal children with autism between the ages of 1.11 year and 12.2 years, who underwent mand training with SSP for periods ranging from 3-10 months. None of them acquired any vocals or speech although most acquired some signs for communication. During this period a second independent variable an antecedent verbal unit was paired with target word during intraverbal fill-in training and its effect was studied on vocal acquisition. Four of the five participants went on to acquire speech defined as acquisition of 7 distinct vocal-verbal behaviors. Acquisition or non-acquisition of vocalization across participants is discussed based on individual differences.

Introduction Experiment 4

Title: The effect of a treatment package including sign mand training with SSP and intraverbal training with paired stimulus on non-vocal children with autism.

Experiments 1 & 2 provided added evidence and extended previous research for the efficacy and sufficiency of sign mand training with and without prompt delays in inducing first instances of speech in children with autism. Experiment 3 provided evidence for additive effect of intraverbal training component with children with autism who had not acquired any speech after sign-mand training with paired vocals. The current study introduces the independent variable from experiments 1 and 3 simultaneously. The intraverbal training component, an antecedent verbal unit paired with target word, and sign-mand training paired with vocals were introduced together as a treatment package with 19 participants across 5 multiple baseline studies.

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Two multiple baseline studies are discussed in detail. The remaining 3 MBL graphs serve as replications and are presented in Appendix 3 (Figures 4.1, 4.4, 4.5) and findings discussed..Five boys and one girl with autism aged between 2.9 years and 9.2 years participated (MBL 4.2 & 4.3). One participant acquired first instance of speech within 7 days of intervention while 4 participants emerged with vocals within 9 weeks with one final participant acquiring first instance of speech in 17 weeks. The evidence of introducing both independent variables together and their effect on vocal emergence in non-vocal children with autism are discussed.

EXPERIMENT 1

Title: The role of stimulus-stimulus pairing during mand training with manual signs and its effect on the emergence of vocals in non-vocal children with autism

Introduction

Skinner (1957) in his book *Verbal Behavior*, described the mand as most significant to the speaker and the first to develop (Sundberg & Michael, 2001). The speaker under motivating operations initiates communication to request what he wants; and while requests can be made using gestures or through pictures, the vocal mand can engage a verbal community to a much larger extent. In the event of delays in the development of vocals, as in the case of children with autism, communication training should begin with teaching mands (Sundberg, 1998) using sign language (Hall & Sundberg, 1987). Mands, can also be acquired more rapidly than other verbal operants, tacts and intraverbals (Scattone & Billhofer, 2008). A child who can make a vocal approximation when presented with a vocal model, can be taught to mand (Sweeny-Kerwin et al., 2007) however due to difficulties associated with prompting non-vocal children with autism, an instructor may be unable to teach vocal mands to those without speech. Earlier studies have demonstrated gains in speech, when sign-mand training procedures were paired with vocals (Carbone et al., 2010; Tincani, 2004) especially with children who had inconsistent speech, or no echoic repertoire. Miliotis et al. (2012) demonstrated vocal pairing of target sound with delivery of preferred item, resulting in increase in vocalizations, in two children with autism. Similar results were observed by Yoon and Bennett (2000) when target sounds were paired with reinforcing consequences in two children with autism with negligible vocal play and vocal imitation.

The current study spanning 6.8 years examines the effectiveness of sign mand training with stimulus-stimulus pairing of the auditory verbal stimulus, in inducing first instances of speech in non-vocal children on the autism spectrum. The study included 58 participants. Each participant was included on a delayed multiple baseline study as the previous participant met criteria. There were 13 multiple baseline studies and 2 participants on A-B design. The following section discusses findings on five male non-vocal participants on one multiple baseline design (MBL 1.0).

Method

Participants and Settings

Five boys Biso, Amaz, Liv, Digun, and Dako (name coded for confidentiality) with a diagnosis of autism participated in this study. All participants enrolled with the organization, and were recommended for the study as initial assessment suggested their non-vocal status. An initial assessment was conducted for each participant, using the Behavioral Language Assessment (Sundberg and Partington, 1998). Participants assessed received a score of Level 1-5 (Appendix 4). An assessment on Group 1 of the Early Echoic Skill Assessment (Esch, 2008) sub-test was conducted to assess vocals under echoic control. Trained supervisors conducted the assessments across 2-3 days for two hours each day. For the participants below four years, the guardians or parents were present if required (in case the child was non-cooperative), however, they did not participate or intervene during the assessment.

Biso was a 3 years old boy diagnosed with autism at the age of 2.3 years by a developmental pediatrician; and went to school for 6 months, before his parents sought therapy on the recommendation of the school. He lived with his parents in Bangalore and was an only child. He had no previous history of intervention. His BLA assessment (Appendix 4) suggests Biso was not cooperative during the assessment and lacked pre-requisites to learning; he did not sit on instruction, did not return reinforcers, and had an inconsistent eye contact. Opportunities were contrived by holding back preferred items for 5 seconds, to assess if he used vocals to ask, however Biso could not communicate using any form of communication and pulled at others hands when he wanted something. He also did not label pictures or objects when he was shown common items and asked, “what is this?” Assessment under the intraverbal domain area on Behavioral Language Assessment (BLA) included presenting a few rhymes which were sung by the assessor and the last word was omitted; for example singing “twinkle twinkle little?” and not filling in the last word “star”. Biso did not fill-in any rhyme. He also did not echo when presented with common words and single syllable sound samples. No vocal play was observed during the assessment. Biso could identify letters A-Z by touching or picking the puzzle pieces and a few body parts by touching them. His score was 18 out of a possible 60 at Level 2 on the BLA. The EESA (VBMAPP sub-test) was conducted at a table while the child sat across the therapist engaging in toy play. The therapist briefly interrupted the play, presented a vocal model of a phoneme/word from Group 1 of EESA, followed by a 2-3 seconds pause. If Biso did not echo, the target word was presented a second time. Data was collected and no reinforcers were provided regardless of the response. Biso's score on the EESA subtest was nil.

Amaz was a docile and shy 2.8 years old boy who was diagnosed 2 weeks before his parents approached this organization. He had a CARS (Childhood Autism Rating Scale) score of 30 and a diagnosis of autism. He lived with his parents in Mumbai and had never received any intervention. His assessment on the BLA (Appendix 4) revealed, Amaz did not scan materials and his sitting was inconsistent. He did not make any eye contact when an adult was presenting preferred items or instructions. Amaz did not use vocals to ask for his preferred items, or label pictures or objects. On the intraverbal domain, (BLA) he did not fill-in any rhyme or animal sound. He also did not echo when presented with common words and single syllable sound samples. During the assessment, vocal play was not observed; and he did not follow receptive one-step instructions, such as clap hands, wave bye etc., or identified his body parts, like pointing at his head or feet when asked. He did not imitate when presented with gross motor or fine motor models. On the presentation of upper case letter cards A-Z, he identified them by pointing. Amaz acquired a score of 14 out of 60 and was at Level 2 on the Behavioral Language Assessment (BLA). His EESA score was nil.

The third participant Liv was a 2.10 years old boy. He lived in Mumbai with his parents, and was diagnosed by a neurodevelopmental pediatrician a few months earlier as being on the autism spectrum disorder. He achieved a score of 12 on the BLA out of a possible 60 (Appendix 4). Liv did not respond to any instructions, did not make eye contact, and did not return preferred items when asked. He could not imitate, follow receptive one-step instructions, or identify body parts. He did not put puzzles in slots or match objects or pictures to sample. He did not have vocal mands, tacts, intra-verbals or echoics. There was no vocal play or babbling observed during the assessment. He achieved a nil on the EESA score.

The fourth participant Digun was 3.8 years old, quiet boy, who lived with his parents and an older sibling in Bangalore. He received a diagnosis of autism, seven months before he joined the experiment. Digun had serious health issues at the time of birth and underwent a major surgery when he was fifty days old. His mother reported delays in all his milestones, and mentioned not providing enough stimulation until the age of 3 years, due to health precautions. Once he developed immunity and became strong at the age of 3 years; he started attending speech therapy and home based occupational therapy; was part of a regular nursery classroom for 6 months, and was reportedly interested in social interaction; sat at one place and followed teacher's instructions. During the course of the BLA assessment, Digun was not willing to sit on the chair and sat on his mothers lap. He sustained eye contact with others; however, his scanning and pointing were inconsistent. He was able to match identical objects, followed a few receptive instructions like touching body parts and identifying objects. Digun imitated when gross and fine motor models were presented and imitated a few oral motor imitations; however, he did not echo or produce sounds while responding to oral motor imitation. There was inconsistent vocal play observed during the assessment during which sounds /pa/ and /mum/ were heard inconsistently. His BLA score was 25/60 at Level 2 (Appendix 4) while his EESA score was nil.

Dako was the oldest participant in the study. He was a 13.5 years old boy, and lived in Mumbai with his parents and sibling. Dako received a diagnosis of autism at the age of 3 years and underwent OT and speech therapy twice a week since he was 3.5 years of age. Dako attended a special school and had a long history of attending occupational therapy and speech therapy for twice a week in the previous 9 years. It was reported by his mother that Dako could identify a variety of pictures and was reading and writing, and was preparing for the National Institute of Open Schooling Exam for Grade 10 taken by special children at his special school. During the BLA assessment, Dako was able to imitate gross motor movements however, he did not respond to oral motor imitations or echoics. He did not use vocals to mand, did not tact or fill-in intraverbals. Dako was unable to match objects or pictures; was not able to identify any picture other than 'apple'. He was not able to read and match, did not follow simple one-step instructions, although he could imitate, he did not echo sounds or imitate oral motor actions with sounds and did not demonstrate vocal play. During task demands and when he had to return preferred items, he exhibited pinching behavior. He also placed inappropriate objects in his mouth. It was reported by the parents that he had screaming and jumping behavior at home and avoided being in the room when visitors arrived. He received a score of 18 on BLA out of a possible 60 (Appendix 4) and received nil on the EESA subtest.

Sessions for all participants were held at the intervention center in a 1:1 set up, where the participants and their therapist rotated between classroom and natural environment. The classroom had a table and two chairs for each; with toys and preferred items placed on a shelf. The natural environment consisted of a play area with a swing, slide, merry go round, seesaw, and trampoline. A computer with pre-loaded rhymes and Indian movie song and dance clips was designated in a different room at the intervention center. Sessions were conducted five days a week for 2 hours in the morning session with one therapist, and another 2 hours with a second therapist in the afternoon with an hours play and lunch break between the two sessions. During the first 2-4 weeks after selection, and before baseline, the therapists performed preference assessments, provided non-contingent reinforcers, and worked on cooperation targets like giving back reinforcers and transitioning from preferred area. This was repeated across all the 5 participants.

Response Definition Measurement and Inter-Observer Agreement

The dependent variable in this study was, the emission of specific vocals, during requesting for a preferred item or activity (independent mand); or vocalizing after the vocal auditory stimulus was presented by the therapist, while the participant was requesting (echoic-mand) or during probe sessions of echoic, tact or intraverbal. The mastery criteria required emergence of 7 distinct instances of vocals or speech.

Baseline and Inervention Probes

Before the introduction of the independent variable, baseline probes were conducted on mands, tacts, echoics and intraverbals (Form 7, Appendix 1) thrice across sessions as per procedures described below. During the intervention phase, the first mand or intraverbal trial (independent variable) of each day, was followed by delayed access (3-5 seconds) to preferred item to observe vocal emergence. If the participant emerged with a specific vocal on the first trial for five consecutive days with the therapist, further probe of five trials was conducted by replicating the stimulus condition and data taken by supervisor. A confirmation of mastery by the supervisor on vocal emerged was followed by acquisition probes and an assessment (Form F12, Appendix 1) on mands, tacts, echoics and intraverbals. These probes (Form F12, Appendix 1) were repeated after each vocal emergence till the participant acquired 7 vocals under stimulus control. A description of probes conducted for mand, tact, echoic and intraverbal (Form 7, & 12, Appendix 1), during baseline and intervention, are presented in detail below.

Mand Probes

The therapist contrived a situation of high motivation as per selected target mands (Form 7, 12, Appendix 1) and delayed access to preferred item by 3-5 seconds. For example, swinging a participant on the swing was delayed by 3-5 seconds thereby providing an opportunity for vocal communication; or allowing the participant to walk to a closed-door and tug at it thereby delaying the opening of the door to observe any form of communicative attempt. No verbal prompts were provided, and the participant was provided access to a preferred item after a pause of 5 seconds without any prompts. If the participant made irrelevant sounds (like grunting, crying, screaming or babbling) or if the participant did not emit any vocal that was audible to the trainer within a feet's distance, the vocal mand for the specific item was noted as absent and transcribed. If the child emitted a sign mand but no specific vocal, it was noted as sign-mand being present without a vocal mand. Approximations of sign-mands were accepted for those with motor difficulties, such as "palm on right cheek" instead of "index, middle and ring finger of right hand on right cheek while holding the little finger with thumb, to make a 'w' sign" The trials were conducted at the table, near the computer and in the play park area. Data were recorded as Yes/No, for vocals emerging as phonemes, approximations, or words.

Echoic Probes

The therapist and participant sat across each other with a table in between. Five sounds were pre-selected (Form F7, Appendix 1). 'aa' (as in apple), 'bu' (as in bus), 'o' (as in open), 'ee' (as in eat), and 'mm'. A therapist presented a vocal model followed by a 3-second pause. A set consisted of five sounds with each presented twice, in random order. The therapist presented the sound by saying, "Say, ___" and waited for 3 seconds for a response. Any vocal emission made by the participant was transcribed in English or Hindi (a phonetically precise Indian language) on each probe trial. For example if the therapist said “bu” and the participant echoed “bae” on each probe it was accepted as a correct response and marked “Yes” on the data sheet as well as transcribed. However if he/she echoed “ta”, “pa” on subsequent probes they were marked as inconsistent and marked “No”. If the participant did not emit any vocal response during the 3-5 seconds following the stimulus presented, the assessor emitted a neutral toned “nice-try” and went on to do some play activity or singing for the participant for about 30-45 seconds before presenting the next target sound. No reinforcers were provided for correct or incorrect responses.

Tact Probes

Tact probes were conducted by presenting pictures. The therapist and participant sat across each other with a table in between. Five pictures of common objects like ball, biscuit, phone, were presented with a discriminative stimulus “What is this?” followed by a pause of 3-5 seconds. Each picture was presented twice in random order. Only one instruction was given and no verbal prompts were provided. If the participant labeled the item, the specific vocal data were marked on the Form (Form 7, 12, Appendix 1). If there was no vocal response during the 3-5 seconds following the stimulus, the assessor emitted a neutral toned “ nice-try” and went on to do some play activity or singing for the participant for about 30-45 seconds before presenting the next target picture. Data were taken as Yes/No directly on the form. If a syllable, approximation or word was observed it was transcribed.

Intraverbal Probes

Intraverbal probes were conducted at the table and natural environment. During intraverbal probes, 2 fun-fill-ins, 2 rhyme fill-ins and 2 animal sounds were pre-selected (Form 7, 12, Appendix 1). These stimuli were randomly selected to provide opportunities for vocalization across a variety of settings such as table top, on the computer or in the play area. Probes for rhyme fill-in and animal sounds were conducted while the therapist sat across the participant with a table between them. Each probe trial was presented twice in random order followed by a 3-5 second pause. For rhyme fill in, the therapist sang a common rhyme like “twinkle twinkle little” and paused for 3-5 seconds for the participant to fill-in “star” or its approximation. For assessing the animal sounds the therapist said, “sheep says” and similarly paused for 3-5 seconds. For the fun fill-in the therapist and the participant could use a play equipment, for example with the participant on the merry-go-round the therapist said “1…2…and”, paused for 3-5 seconds and provided an opportunity to say, “spin”. If the participant did not vocalize in the 3-5-seconds, during probes, the therapist did not complete the last word and data was transcribed “No” on the form. However if one-syllable, word approximation or word was emitted the therapist transcribed it immediately.

Inter-Observer Agreement

Before the introduction of the independent variable, two observers, the therapist and the supervisor, measured the target behavior by taking data independently and simultaneously. An assessment was conducted using Form 7 (Appendix 1). Any vocal emitted was marked “yes” on the data sheet. In the instance no vocalization was emitted, a “no” was marked. Baseline probes on mands, tacts, echoics and intraverbals were conducted thrice across sessions. Both observers collected data on 100% baseline trials for each participant, to confirm non-vocal status of participants.

On acquisition of mastery criterion for each vocal, the supervisor, and therapist collected IOA data (Form 12, Appendix 1) independently on acquisition probes by replicating the stimulus conditions. If the supervisor did not observe the emission of specific vocal or if there was disagreement on the vocal approximation under the relevant antecedent conditions (MO), participant training was continued and the IOA was repeated a week later till agreement of minimum 80% was reached on specific vocal. If IOA was 80%, the vocal was recorded as acquired.

Exact agreement was calculated, by dividing the agreements with total agreements and disagreements. An average of values across sessions was calculated, and multiplied by 100. Mean baseline agreement percentages were 100% across all five participants. Mean acquisition IOA probes for Biso, Amaz, Digun, and Dako were 97%, 91%, 100%, and 91% respectively. The mean IOA across the five participants was 95% (range 91%-100%) presented in Table 19 (Appendix 2).

Stimulus Preference Assessment

A detailed preference assessment was administered for each participant, prior to the study. Eight sessions of one hour each were conducted across three to four days. The participant was rotated between three zones, the play park, tabletop and the computer area. In the play park the free operant method (FOPA) was administered (Roane, Vollmer, Ringdahl & Marcus, 1998). Each participant indicated preferences from various play equipment's like trampoline, seesaw, swing, slide, and merry-go-round; these were ranked 1-5 based on the duration spent with each (Form 9, Appendix 1). At the tabletop the MSWO procedure (DeLeon & Iwata, 1996) was administered to rank a variety of preferred items under the category of toys and edibles. Toys like bubbles, light tops, slinky, play-doh, slime, musical toys, piano, crayons, book, puzzles were presented and edibles like chocolate, chips and kurkure (a salty crispy) were offered. The top 10-15 preferred items from tangibles, edibles, play area and music (computer) were identified. A third preference assessment was conducted at the computer where a variety of rhymes and songs were played one by one for 10-20 seconds and preference was recorded. The final list of preferred items for each participant are presented in Table 8 below.

Table 8: List of Preferred Items

Participants	Preferred Items
Biso	Toys: Light toy, Musical toy, Bubbles, Book, Squeezy Ball, Piano, Puzzle, Music Outdoor: Swing, Trampoline, Merry-go-round, Rocking-horse Contrived: Jump, Push
Amaz	Toys: Light toy, Musical toy, Puzzle, Crayon, Pencil, Book, Music on Computer Outdoor: Swing, Slide, Ball Edibles: Biscuit, Chips, Water, Banana
Liv	Toys: Musical toy, Music on phone, Music on computer, Pen Outdoor: Trampoline, Slide, Swing, Merry-go-round Edibles: Chips, Chocolate, Water Contrived: Jump, Open
Digun	Toys: Bubbles, Book, Puzzle, Toys, Music on computer Outdoor: Swing, Trampoline, Merry-go-round, Bicycle Edibles: Biscuit, Chips, Chocos Contrived: Jump, Toilet
Dako	Toys: Book, Outdoor: Swing, Merry-go-round, Play area Edibles: Chips, Juice, Water (Pani in Hindi), Apple Contrived: Out, Move, Jump

Target Selection

Based on the preference assessment six mand targets were selected for each participant. All efforts were made to ensure targets varied with stimulus salience and there was no similarity among stimuli while they differed by their features. The six targets selected for Amaz were “ball”, “toy” (musical), “book”, “slide”, “music” (on computer), and “biscuit”. Targets were selected in a similar manner for Biso, Liv, Digun and Dako.

Experimental Design

A delayed multiple baseline design across subjects was used with 5 participants to demonstrate experimental control. Each participant joined the study as they became available after the previous participant emerged with minimum 1-3 vocals.

Procedure

Baseline

Baseline assessments and probes were conducted before intervention to assess vocalization under stimulus control. Mand, echoic, tact and intraverbal fill-in assessments were conducted as mentioned in detail under baseline probes (Form 7, Appendix 1). Biso, Amaz, Liv, Digun and Dako did not emit any vocals during the detailed assessment and baseline IOA was 100% for all 5 participants.

Sign Mand Training with Stimulus-Stimulus Pairing

During the intervention, the therapist presented a preferred edible or tangible item in view; or led the participant to a preferred activity area, such as the vicinity of a swing or trampoline after ensuring a brief period of deprivation. If the participant demonstrated no interest within 2-5 seconds, the therapist discontinued the trial and moved on to a different preferred stimulus for training. However, if the participant demonstrated interest (by reaching out, looking at the stimulus, or tugging at hand), the therapist delivered a full physical prompt for the corresponding sign and paired the auditory target word. The independent variable was represented (Flow Diagram 1) as, “Participant demonstrates motivation → physically prompt manual sign + pair auditory target word → prompt fade sign + pair auditory target word → give preferred item → 2 sec pause → pair auditory target word". The auditory target word was repeated thrice with a 2-second pause between each. The preferred item was delivered after the second, but before the third pairing of the auditory target word. The participant was allowed to consume the edible or play with the item for 1-2 minutes followed by a repetition of the same trial depending on the motivating operation or was transitioned to another area. Each mand session consisted of minimum 40 stimulus-stimulus pairing trials during a two-hour session.

Integrity of the Independent Variable

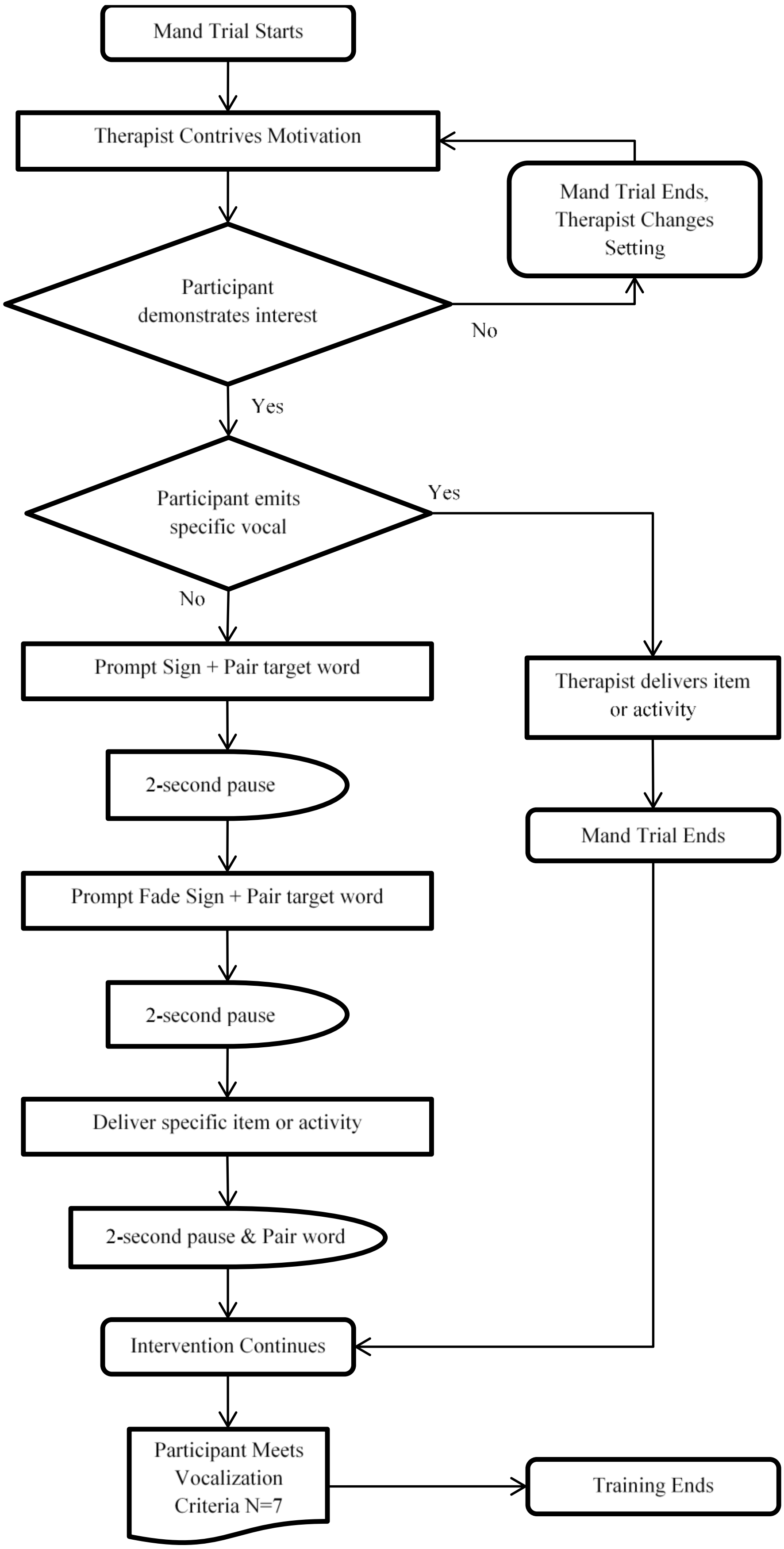
An independent observer assessed the integrity of the independent variable by observing 50% (100) mand training trials in the first week of intervention (Form 11.1A, 11.1B, Appendix 1). Thereafter treatment integrity checks were conducted for one trial per target per participant per month that aggregated to 6 trials/month till intervention lasted. Each target trial was observed equal number of times. Observation was conducted on randomly selected trials by the supervisor. Five component skills were observed during the integrity checks presented in Table 8.1.

Table 8.1: Mand Training Component Skills

S.No	Component Skills	Mark
1	Completed a brief preference assessment or motivation contrived for a teaching trial	Y/N
2	Ascertained reach out before training	Y/N
3	Prompted the sign and paired auditory target word with 2 second delays	Y/N
4	2 second pause between three vocal stimuli presentation	Y/N
5	Delivered preferred item after saying target word twice and once after delivery	Y/N

Each component skill mentioned in Table 8.1 needed correct implementation for the trial to be scored as entirely correct or incorrect. Treatment integrity was calculated by dividing the correct trials with the total number of trials. Of the 100 trials observed in the first week if the score was less than 80%, the intervention was paused and

Flow Diagram 2: Manual Sign Mand Training with SSP



re-training was provided to the therapist until he/she was able to demonstrate competence in mock trials with supervisor. The treatment integrity (Table 18, Appendix 2) for this experiment (MBL 1.0) was 89% (Range 80% to 93%) and for all 13 multiple baselines and 2 single-subject designs was 89% (Range 73% to 100%).

Results

Figure 1 demonstrates Biso's first vocal emerged within two weeks of intervention. His first vocal was /moo/ for the mand music. Of the 6 mand targets selected, he acquired 4 vocals in the third week, /pas/ for puzzle, /toe/ for toy, /jum/ for jump and /bu-bu/ for bubbles. Vocals /poo/ for push and /wee/ for swing, emerged in the fifth week of intervention. All 7 vocals emerged after signs were paired with vocals, under conditions of motivating operation, between the second and fifth week. Biso acquired 6 manual sign mands prior to vocal emergence and one manual sign for mand "push" post seventh vocal. His vocals were single syllable sounds and his acquisition of signs preceded his vocal emergence. Data collected from his IBI records showed, acquisition of 18 targets in 5 weeks under the domain areas of imitation and receptive instructions. He continued to acquire 29 manual signs over the next 32 weeks and acquired 4 more vocals during this period. 32 weeks into the intervention he stopped using sign mands and used vocals for communication. His intraverbal program was started after he achieved criterion for vocalization and he learnt to fill in animal sounds. Overall it may be noted that Biso had a good rate of learning. Table 8.2 below enumerates Biso's vocal emergence in detail.

Table 8.2: Biso Vocal Emergence Data

	Target Word	Vocal Emerged	Days to Manual sign	Days to Voc Emergence	Operant
1	Music	Moo	5	8 days	EM*
2	Puzzle	Pas	10	14 days	EM
3	Toy	Toe	12	14 days	EM
4	Jump	Jum	9	14 days	EM
5	Bubbles	Bu-bu	5	8 days	EM
6	Push	Poo	30	17 days	EM
7	Swing	Wee	13	19 days	EM

*EM = Vocal as Echoic-Mand

Amaz joined the intervention after Biso had acquired 2 vocals. He obtained similar results, as his vocal emergence was observed between the third and fifth week of intervention. For Amaz all 7 vocals emerged very quickly. The first word he vocalized was /ball/. The following week he vocalized /music/, /toy/ and /side/ for slide, /bicuit/ for biscuit. By the fifth week Amaz vocalized /book/ and /banana/. He articulated words with clarity although he omitted some sounds in the words. His first seven speech sounds were words, which he used for requesting objects and items. Table 8.3 below provides details on his vocal emergence. Amaz did not acquire any signs during training and acquired independent mands in the presence of the desired item.

Table 8.3: Amaz Vocal Emergence Data

	Target Word	Vocal Emerged	Days to Vocal Emergence	Operant
1	Ball	Ball	11 days	Mand*
2	Music	Music	16 days	Mand
3	Slide	Side	16 days	Mand
4	Biscuit	Bicuit	18 days	Mand
5	Toy	Toy	18 days	Mand
6	Book	Book	22 days	Mand
7	Banana	Banana	28 days	Mand

*M=Independent Mands

During the same period, data from his IBI program suggests acquisition of his first 2 gross motor imitations, 5 receptive one step instructions and 2 receptive body parts. He also learnt to make eye contact when he wanted something or on name-call. Amaz did not acquire any imitations with objects. Oral motor imitation was not a teaching target on his program. During 5 weeks he acquired 9 learning targets.

Liv was the third participant on the multiple baseline and started intervention once Amaz met criterion with 3 vocals. Liv was on the intervention for a period of 48 weeks and during this period he remained non-vocal. He acquired 11 sign mands to request for preferred items and achieved his first sign for chips in 11 weeks. Liv mastered the second, third and fourth sign in 24, 18, 17 weeks respectively, subsequently taking as less as 3 weeks to acquire a new sign-mand. Details of his days to acquisition of sign-mands are presented in table 8.4 below. Data from his IBI program collected after 48 weeks, suggested acquisition of 8 imitations (2 with objects, 3 gross motor imitations and 3 imitations in rhymes), 2 receptive body parts (head and stomach) and 1 cued one step instruction with objects present. 8 weeks after introduction of the independent variable, an observing response was introduced on target. This included looking at the experimenter when his name was called after reach out and before the manual sign was prompted. Liv took 216 days to acquire responding to name with eye contact.

Table 8.4: Liv Vocal Emergence Data

	Target Word	Vocal Emerged	Days to Sign	Operant
1	Chips	NA	58	Mand
2	Water	NA	119	Mand
3	Computer	NA	86	Mand
4	Toy	NA	82	Mand
5	Music	NA	13	Mand
6	Jump	NA	13	Mand
7	Open	NA	32	Mand

Digun was introduced as the fourth participant on the delayed multiple baseline after 8 weeks of Liv being on the intervention. Liv had not acquired any vocal yet and his intervention was continued, however, two other previous participants had made progress and acquired vocals. In the eighth week after the introduction of the independent variable, Digun started echoing under conditions of motivating operation repeating the initial sound of words after the therapist. He echoed /ba/ for biscuit and /mu/ for music as an echoic-mand on the same day. On acquisition probe (Form F12, Appendix 1) conducted post second vocal emergence he also echoed /mee/. In the twelfth week after a preference assessment, book and puzzle were added to the teaching targets. Digun echoed /bo/ as an echoic-mand for book taking 3 days to sign and vocalize. In week sixteen Digun echoed /pu/ for puzzle and /ja/ for jump (on the trampoline) in 22 weeks (counting five working days/week) and achieved mastery criteria. Table 8.5 below demonstrates details of his vocal emergence. Digun had not acquired any sign mand when he vocalized his first sound however before his fourth vocal he was independently using 7 signs (toilet, merry-go-round, open, computer, cycle, chips and chocos) for requesting. Of the 7 vocals acquired Digun produced vocals for the first 2 mands, biscuit & music, and acquired manual signs few weeks later for the same. He acquired his fourth vocal book along with the manual sign. For puzzle, toy and jump Digun achieved manual signs first and vocals emerged later. As is evident, Digun vocalized the first phoneme of the word omitting the last. A binder review suggested that during the same period he acquired 23 receptive instructions, 4 one-step instructions, 5 environmental objects, 4 body parts, 4 objects, 1 picture and learnt to follow 4 verb actions. He also learnt to imitate 5 gross motor movements taking 3 weeks to learn his first imitation. He eventually used phrase speech and went to mainstream schooling.

Table 8.5: Digun Vocal Emergence Data

	Target Word	Vocal Emerged	Days to Manual Sign	Days to Voc Emergence	Operants
1	Biscuit	Ba	58	38	EM
2	Music	Mu	46	38	EM
3	Say /mee/	Mee	Probe	38	Echoic
4	Book*	Bo	3	3	EM
5	Toy	Ta	78	81	EM
6	Puzzle *	Pu	10	19	EM
7	Jump	Ja	46	111	EM

* Preference assessment conducted

Dako the last participant of this delayed-multiple baseline was on baseline for a period of 8 weeks. His challenging behavior reduced and he joined the experiment after Digun had acquired 3 vocals. At the age of 13.5 years with a long history of interventions, he showed escape motivated behaviors and was on non-contingent pairing where preferred items were delivered to him without any demands. His baseline probes were conducted two weeks prior to intervention. 3 weeks after intervention Dako vocalized /chee/ for chips his first syllable as an echoic-mand. In week 7, he vocalized /paee/ for pani (water in Hindi) and /swi/ for swing. Following a brief preference assessment juice and book were added to his target mands. 12 weeks since the intervention started and within 2 weeks since the target juice was introduced, Dako used the vocal echoic-mand /jun/ to reach mastery criteria for the sign as well as vocal. In week 16 from the beginning of intervention and 8 weeks since introduction of target he produced the vocal /boo/ for book. In week 17 (counting 5 training days/week) Dako vocalized /movo/ for move, when the computer screen was blocked while he watched his favourite songs. He acquired the seventh vocal /opu/ for open, which was a contrived mand for opening the door, in the 28th week (Table 8.6). During acquisition probes (Form 12, Appendix 1) conducted after each vocal he did not echo or repeat after the therapist, tact or fill-in on an incomplete rhyme. Data collected until the seventh vocal suggested, Dako acquired 3 signs before he acquired the same vocals. For the remaining target words he echoed after the pairing. He took 21 days to acquire the sign for swing, 30 days to acquire the sign of book, and 44 days to acquire the manual sign for "open". All his mands were acquired as echoic-mands. Follow up data, obtained from his binder suggested he also mastered visual performance skills of matching objects and pictures, and receptive responding on 21 one-step instructions, 5 body parts and 9 contextual one-step instructions. He learnt to receptively identify 5 objects, 6 pictures of common nouns, 5 fruits, 3 colours and 1 environmental object and mastered 5 imitations with objects.

Table 8.6: Dako Vocal Emergence Data

	Target Words	Vocals Emerged	Days to Manual Sign	Days to Voc Emergence	Operant
1	Chips	Chee	-	15	EM
2	Pani (Water)	Paee	-	32	EM
3	Swing	Swi	21	32	EM
4	Juice*	Jun	-	10 (59)**	EM
5	Book*	Boo	30	40 (78)**	EM
6	Move	Movo	-	85	EM
7	Open	Opu	44	139	EM

* Preference assessment conducted ** Days from mand start date

Liv the 3rd participant continued on the intervention for 46 weeks until Dako, the fifth participant on the multiple baseline emerged with vocals. During this period Liv did not acquire any vocals. He left the study after 48 weeks. Figure 1 below represents the data on the delayed MBL graph.

Figure: 1.0 Experiment 1

Effect of introducing mand training with SSP on non-vocal children with

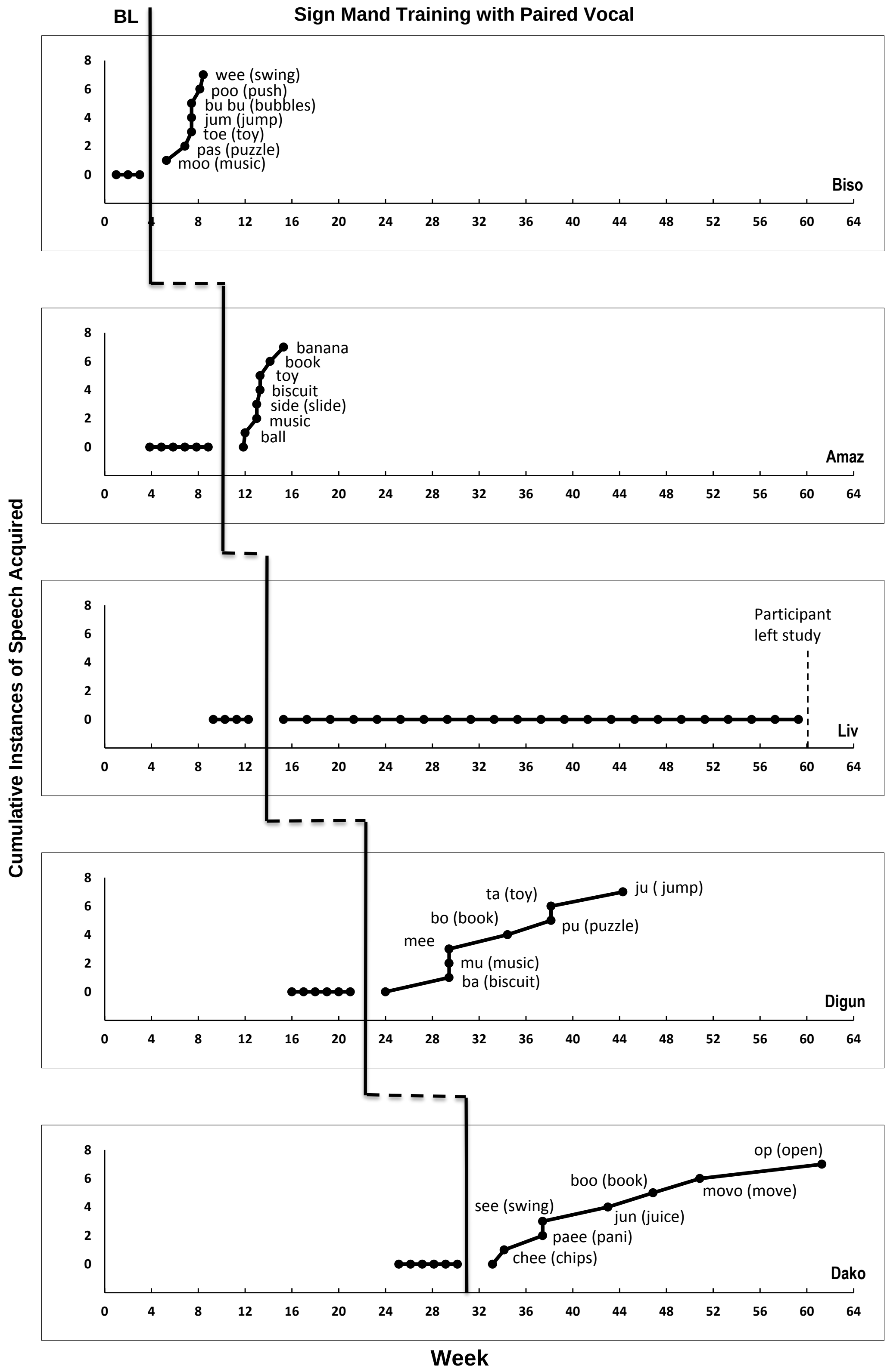


Figure 1.0: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Discussion

The delayed multiple baseline (Figure 1) reliably demonstrates the role of stimulus-stimulus pairing in the emergence of vocalizations under motivating operation conditions. Liv was the only participant on MBL 1.0 who remained non-vocal despite being on the program for 48 weeks. The remaining four participants vocalized for the first time between weeks 2 – 28.

Table 8.7: Participants Weeks to Vocal Emergence

Name Code	Week of 1st Vocal from Mand Start	Week of 7th Vocal acquired
Biso	2	5
Amaz	3	5
Liv	NA	NA
Digun	8	22
Dako	3	28

The BLA scores of the five participants Biso, Amaz, Digun, Dako and Liv ranged from 12-25 of a possible 60 at Level 1-2 (Appendix 4) suggesting very basic skills at intake. Individual differences were observed in participants in imitation skills and cooperation (e.g., sitting on instruction). Biso and Amaz despite weak gross and fine motor imitation acquired first instances of speech fairly quickly, suggesting negligible effects of motor imitation skills on vocal evocation. Similarly, lack of cooperation during baseline does not appear to be a variable affecting rate of vocal emergence, as less cooperative participants Biso, Amaz and Dako had first vocals emerge earlier than Digun. This suggests, the role of motivating operations in eliciting cooperation during intervention.

Observing responses such as, looking towards the therapist, have been considered a key response expected from the child during stimulus-stimulus pairing (Dinsmoor, 1995a, 1995b; Petersdottir et. al., 2011). Digun's observing response was already well developed however the remaining four participants had very limited eye contact. During the experiment observing prompts like calling out the child's name, to get the participants' eye contact, as in previous studies were not implemented. Data suggests

Biso, Amaz and Dako acquired first vocal within 3 weeks much earlier than Digun. Early vocal emergence in participants' lacking observing responses suggests eye contact during stimulus-stimulus pairing might have little or no effect on vocal emergence. It may also rule out any blocking effect that the verbal auditory stimulus (presented during pairing) might have; as children with autism often exhibit stimulus over-selectivity while looking at different parts of the face. Training for observing responses was initiated for Liv, due to non-acquisition of vocals 16 weeks after introduction of the independent variable; however Liv took 40 weeks to achieve eye contact and its effect on the intervention could not be observed as he left the study.

During stimulus-stimulus pairing, the neutral stimulus i.e. a specific vocal auditory target was emitted by the therapist, twice before and once after the delivery of preferred item. This pairing of the specific target vocal (ex. swing) with the established reinforcer (getting to sit on the swing), possibly led to the vocal auditory stimulus acquiring reinforcing properties, and thus becoming a conditioned stimulus. While previous research on stimulus-stimulus pairing (Sundberg et al., 1996), involved pairing an arbitrary stimulus with preferred stimuli e.g. pairing target word "mirror" with tickle or the sound "eee" with being thrown up; in the present experiment functional words were paired with reinforcers for lasting effects. Of the 5 participants, Biso, Amaz, Digun and Dako met the mastery criteria of n=7 vocals rapidly and emerged vocals were brought under stimulus control of the mands.

Three participants had no histories of intervention and were below 4 years, however, Dako at the age of 13.5 years vocalized his first syllable in 3 weeks of intervention. This clearly demonstrates SSP can be effective in developing vocals in individuals with autism irrespective of age.

The vocal responses acquired in the current study during conditions of paired vocals and motivating operations were clearly effective in the success of the protocols and vocal emergence. Biso, Amaz, Digun, and Dako's vocalizations were likely under the multiple control of MO, and the auditory target word paired, as in the study with SGD's by Gevarter et al. (2015). The effect of SSP on vocalizing was evident from the 28 vocals emerged (mastery criteria of n=7 vocalizations), observed across 4 of the 5 participants. The similarity of the emergent vocalizations to the paired auditory stimulus confirmed the role of automatic reinforcement during vocal emergence (Bijou & Baer, 1965; Skinner, 1957). Vocalizing /o-p/ for open, /jun/ for juice, /side/ for slide, and /ju/ for jump suggests SSP established the auditory verbal stimulus as a conditioned reinforcer. One of the reasons for this pairing effect was the selection of highly preferred items after a preference assessment and pairing trials only after a brief preference assessment under conditions of motivating operations. Rotating the participants across various environments like the play area, computer and tabletop toys kept the value of preferred items high. Normand and Knoll (2006) emphasized the necessity for identification of potential reinforcers for pairing, as well as the rigor of stimulus selection. He suggested stimuli used in pairing should serve as reinforcers for the intervention to be successful. During this study, a minimum of 6 mands selected for training kept the effect of satiation low and provided the experimenter a high number of opportunities for manding. Random vocalizations unrelated to the paired vocal were not observed and the emerged vocals were under multiple controls of the motivating operation and vocal model emerging as echoic-mands in Biso, Digun, and Dako. The three participants consistently vocalized after the paired auditory stimulus as echoic-mands, however did not echo on echoic trials during acquisition probes. Amaz however, emerged with independent vocals in the presence of preferred items. No attempts were made to study the emergence of vocalization with items missing (pure mands) as it was beyond the scope of this study.

During acquisition probes conducted on echoic, tact and intraverbal trials after the emergence of each vocal; Digun was the only participant who echoed “mee” on an echoic probe after he had acquired his first two vocals as echoic-mands. Echoic behavior did not emerge for any other participant despite emergence of echoics during presentation of auditory verbal stimuli under mand conditions. This suggests the role of motivating operations during SSP.

As the current study was based on communication training conducted during mand conditions under the presence of relevant MO, manual sign-prompts provided by the experimenter for the preferred item led to 4 of 5 participants acquiring sign mands for communication. Biso acquired 12 manual signs of which 6 signs were followed immediately by vocalizations; Digun’s first two vocals preceded sign acquisition however, he acquired manual-signs for the last three echoic-mands /ta/ for toy, /pu/

puzzle and /ja/ jump prior to vocals; taking 78, 10 and 46 days respectively for acquisition of manual-signs while his vocals emerged on 81, 19 and 111 days respectively. Dako acquired sign mands taking 21, 30 and 44 days respectively for requesting "swing", "book" and "open" prior to vocal emergence in 32, 40 and 139 working days to acquire vocals for the same mands. These results confirm previous studies (Tincani, 2004) indicating manual-signs may function as prompts for the emergence of vocalizations in some participants. The signs were acquired through operant conditioning while the verbal stimulus was paired through respondent conditioning. It may be concluded that teaching manual-signs had no blocking effect on the pairing of the target verbal stimulus as observed in the case of Biso, Digun and Dako. While manual-signs were prompted using physical prompts and the target word was paired twice with the sign prior to access to the preferred item; stimulus over-selectivity was not observed, nor did the signs mask the paired vocal. Few participants such as Biso and Dako acquired manual-sign mands before or along with emergence of vocals. Amaz on the other hand did not acquire any manual-signs and started vocalizing independently under motivating operations while Digun's initial vocals emerged with vocal pairing while the 5th, 6th and 7th vocal emereged after signs. The results of this study support previous research (Sundberg & Sundberg, 1990; Wraikat et al., 1991) on acquisition of response with sign-mand training in 3 of the 5 participants.

Echoic and intraverbal probes (Form 12, Appendix 1) conducted after each participant acquired vocals presents an interesting scenario. None of the participants echoed when asked to repeat a vocal model, nor did they fill-in any intraverbal syllable or word suggesting the behavior of vocalizing was under the stimulus control of motivating operations and not any other discriminative stimuli. Data taken from the participants' records suggest Biso was able to echo basic sounds like /a/, /e/, /o/ post vocal emergence after 12 weeks. Similar results were observed with Amaz and Dako. It can be concluded that echoics may not be a pre-requisite for vocal emergence as suggested in previous studies (Drash & Leibowitz, 1973; Guess, Sailor, & Baer, 1976; Lovaas, 1977) and mand training should be initiated as a starting point for those with limited or negligible verbal ability (Shafer, 1994). Once vocals emerge and stabilize, transfer of stimulus control procedures can be used to develop echoics (Drash et al., 1999) with further training.

The BLA assessment for each participant suggested three participants Amaz, Biso and Liv lacked gross motor, fine motor or object imitation skill while Digun and Dako both could imitate many motor actions. It is interesting to note that both Biso and Amaz reached mastery criteria of vocalization (n=7 vocals) within 5 weeks whereas Digun and Dako reached mastery by 28 weeks. While correlations between motor imitations and manual-sign acquisitions have been strong and may expedite communication (Gregory, DeLeon & Richman, 2009), the results above are at some variance.

While previous studies on SSP (Esch et.al., 2005; Miguel et al., 2002; Normand & Knoll, 2006; Stock et al., 2008; Sundberg et al., 1996; Yoon & Feliciano, 2007) have demonstrated discrepant effects based on pre-existing vocals, these results en masse do not suggest the success or failure of SSP due to the unique vocal characteristics of each individual (Esch et al., 2009). The behavioral literature however has demonstrated fair amount of success with SSP for increasing vocal responding using SSP (Kelleher & Gollub, 1962; Williams, 2002).

Replications Experiment 1

Replications of Experiment 1 were conducted using mand training with SSP across another 53 participants, displayed on an additional 12 delayed multiple baselines (MBL), i.e. total number of participants in Experiments 1 n=58. While data for the first 5 participants (MBL 1) have been explained in detail above, other participants were added to the experiment as a previous participant acquired a minimum of one vocal. At times when a participant did not acquire vocals for a minimum 3 months, a participant was added on the MBL while the previous continued on the intervention. Tables below (MBL 1.2 – 1.13) provide details of participants on each delayed-MBL with regards to age, gender, and number of days to first vocalization, as well as number of days until they met criteria (n=7 vocalizations). Full data sets including vocalization graphs are available in Appendix 3.

Each delayed-MBL had between 3-6 participants. Two concurrent participants continued as single-subjects with no further participants available as they met criteria.

Of the total n=58 participants in this experiment, 48 acquired vocals while 10 remained non-vocal. Mean IOA on vocal emergence across all MBL's was 89% (Range 54% to 100%) confirming the emergence of vocalization.

Summaries of participants in Experiment 1 replication studies MBL 1.2-MBL 1.13: Age, gender, onset of vocalizations and time to meeting criterion.

MBL 1.2

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	SAJ	8.0	M	28	270
2	RRA	2.4	M	44	82
3	RJO	4.6	F	11	69
4	ASIN	4.8	F	22	64
5	ANA	2.5	M	87	133
6	DSA	2.10	M	19	144

MBL 1.3

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	AGU	1.5	M	46	46
2	KRD	2.10	M	0	0
3	ASING	1.7	M	117	271
4	ABAD	3.9	M	28	165
5	HDE	9.6	M	0	0
6	RSA	2.11	M	27	68

MBL 1.4

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	CTI	6.10	M	71	227
2	SMI	3.10	M	274	316
3	KSH	1.4	M	116	133

MBL 1.5

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	NNA	3.2	M	46	72
2	AUA	2.6	M	241	385
3	SMA	5.10	M	174	378
4	AMO	4.4	F	0	0

MBL 1.6

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	PSE	5.11	M	72	254
2	IPA	4.2	M	15	67
3	VPRI	5.7	M	299	644

MBL 1.7

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	SPR	4.6	M	0	0
2	PGO	2.9	F	51	104
3	PNA	2.11	M	5	23

MBL 1.8

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	RPA	2.9	M	7	32
2	SVER	5.8	M	81	259
3	AKU	2.5	M	23	207
4	RDA	3.4	M	706	778

MBL 1.9

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	ACH	4.10	M	27	273
2	PPA	2.11	M	69	135
3	ASH	3.9	M	49	237
4	DSO	2.7	M	51	120

MBL 1.10

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	SSE	3.8	M	18	220
2	USE	2.7	F	13	32
3	SRA	4.7	M	0	0

MBL 1.11

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	AJOS	6.2	M	0	0
2	SMO	3.0	F	91	133
3	MSH	5.8	M	16	292
4	ARE	6.7	M	0	0
5	SVEE	4.2	M	220	229

MBL 1.12

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	SRE	5.2	M	75	76
2	VKI	3.10	F	33	33
3	ZMO	2.9	F	13	28
4	PKA	4.6	M	0	0
5	AQU	4.2	M	42	44
6	SAM	5.2	M	0	0

MBL 1.13

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	SSRU	2.11	M	48	125
2	PKE	9.3	M	10	58
3	AAK	3.0	M	176	225
4	MAR	3.4	M	282	292

Summaries of participants in Experiment 1 replication study Single-Subjects: Age, gender, onset of vocalizations and time to meeting criterion.

Single – Subject

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1.1	NPR	5.6	F	31	39
1.14	RKA	5.6	F	48	161

Results from 58 participants demonstarted, 48 (83%) participants emerged with vocals under mand conditions with SSP, presenting evidence of the success of the intervention. Data for 51 participants in the replication studies, are presented in 12 multiple baseline graphs (Figures 1.2-1.13) in Appendix 3. Two participants acquired vocalization as single-subjects on A-B design, and their data are presented (Figure 1.1, Appendix 3).

Each participant on the following six delayed-MBLs (MBL 1.2, MBL 1.4, MBL1.6, MBL 1.8, MBL 1.9 & MBL 1.13) acquired vocalization to mastery criterion (n=7 vocalizations). A total 9 of 51 participants on the replication experiments did not acquire vocalizations. One participant in each of the three MBLs (MBL 1.5, MBL 1.7, MBL 1.10,) did not acquire vocalization; while two participants each in MBLs (1.3, 1.11 & 1.12) remained non-vocal.

Vocal Emergence < 50 days

On the implementation of the independent variable, the first vocal emerged for 27 participants particularly fast i.e. within 50 days. Of these 12 participants RJO, ASIN, DSA, (MBL 1.2), IPA, (MBL 1.6), PNA, (MBL 1.7), RPA, AKU, (MBL 1.8), SSE, USE, (MBL 1.10), MSH, (MBL 1.11), ZMO, (MBL 1.12), and PKE (MBL 1.13), emerged with the first speech sound in <25 days after the implementation of sign-mand training with SSP. All participants had a BLA score below 24 of 60 at Level 2.

Three of these 27 participants acquired mastery criteria of n=7 vocalizations within a week of vocal emergence.

Vocals emerged for RJO, a 4.6 year-old girl, as echoic-mands under conditions of motivating operations. She acquired her first vocal in 11 days and emerged with her fourth vocal as an independent mand for a highly preferred snack in 27 days. Her first three vocals were under the joint control of the echoic and motivating operation. She acquired n=7 vocals in 69 days taking approximately 10 days to acquire each vocal. All her vocals emerged as phonemes, and she continued to use sign mands through the entire duration of the study generalizing signs across all environments. She also continued on 25-hours/week of intervention beyond the study.

ASIN was 4.8 years old girl (BLA score 12, Level 1) who displayed screaming behavior and an inability to wait for reinforcers. To meet mastery criteria, she acquired five phonemic echoic-mands and two independent mands acquiring the first vocal in 22 days and reached mastery criteria within 64 days.

Some other participants acquired vocals within 2-3 weeks of introduction of the mand training with stimulus-stimulus pairing (namely IPA, PNA, USE, ZMO, and PKE). Data for these participants are displayed on MBL 1.6, MBL 1.7, MBL 1.10, MBL 1.12, MBL 1.13, respectively. While these participants had Level 1 BLA score during baseline, all emerged with independent words, spoke with clarity, had high learning rates and at the end of the intervention were attending school without a facilitator.

First vocal triggers rapid emergence of n=7 vocals

The first vocal in a few participants were found to be a trigger, for the emergence of a cluster of vocals as observed in AGU, VKI and AQU where all vocals were acquired on the same day. AGU, a 1.5-year-old boy, took 46 days and emerged with all 7 vocals on the same day with 6 phonemic vocals emerging as echoic-mands and one as an echoic on the acquisition probe. VKI, a 3.1 years old girl acquired the first speech word /ee/ for chips on day 33 of the intervention and on the same day achieved mastery criteria of n=7 vocals by echoing 6 phonemes suggesting vocals under stimulus control of the vocal model. AQU a 4.2 years old boy acquired his first vocal /to/ for toy in 42 days and within the next 2 days reached mastery criteria with independent mands suggesting all vocals were under stimulus control of the motivating operation.

Vocal emergence and the verbal operant

Pairing of vocal model under conditions of motivating operations should lead to emergence of echoic mands or independent mands. However results from all experiments suggested first vocals were acquired under different conditions. Vocal emergence for AGU occurred under stimulus control of the motivating operation as well as the vocal model however he did not echo if the MO was absent; vocals for VKI were triggered under MO as well as the vocal model presented during SSP and also under the stimulus control of the echoic model without MO as she vocalized on acquisition probes. The third participant AQU acquired all vocals under the stimulus control of the MO only as evident from the lack of responding on echoic model presented during SSP.

Early emergence and long intervals to mastery criteria

For some participants, early emergence of vocals did not mean that they met mastery particularly quickly. For example, DSA was 2.1 years old, who was social and loved to play. He acquired his first two independent vocals within 3 weeks and took 144 days to reach mastery criteria (n=7 vocalizations). His first 2 vocals emerged with sign mands and were articulated with clarity as a whole word. His third and fourth vocal emerged in 3 and 4 weeks respectively after the previous acquired vocal. However the interval for the emergence of the last 3 vocals was 12 weeks long. It may be assumed that once independent vocals under motivating operations were reinforced the manual signs went on extinction leading to a gradual drop in signs which seized to be prompts. This could have led to the delay in reaching mastery criteria. Follow up suggests DSA acquired phrase speech and joined mainstream school overcoming core characteristics of autism.

SAJ at 8 years of age, had been on an IBI intervention for 4 years and had a few gross motor imitation and visual performance skills with a BLA score of 20 at Level 2. He had very little vocal play and did not cry suggesting little use of vocal musculature. SAJ, acquired sign-mands prior to vocalization. His first vocal emerged as phoneme /mm/ for music within 28 days of the intervention. His 2nd and 3rd vocals /pa/ for push and /ba/ for bubbles emerged in another 10 days. He took 58 days from the start of intervention (excluding a 15-day vacation) to emerge with his 4th vocal /cha/ for chips and another 7 days to acquire his 5th vocal /sss/ for swing. After this there was a long pause in vocal emergence and his final two vocals emerged in 270 days as intraverbal fill-ins in rhymes (“eeya-eeya-oh” for Old Mac Donald; and “papa” for Johnny Johnny rhyme) during group time. The first 5 vocals for SAJ were echoic-mands.

Children 1.4-3.5 years

Of the 51 participants in Experiment 1 replication studies, 24 were very young, between ages 1.4-3.5 years. Of these, only one namely, KRD (MBL 1.3), remained non-vocal; the remaining 23 participants, achieved the mastery criteria (i.e. n=7 vocals) for vocalization although the time period of vocal acquisition varied considerably, from as less as 23 days to a maximum 385 days (excluding RDA, an outlier).

Fifteen participants namely, RRA, DSA, AGU, RSA, NNA, PGO, PNA, RPA, AKU, PPA, DSO, USE, VKI, ZMO and SSRU (details provided in MBLs 1.2, 1.3, 1.5, 1.7, 1.8, 1.9, 1.10, 1.12 and 1.13 respectively) acquired first vocal within 5-70 days and met mastery criteria within 23-144 days. This suggests these 15 participants took an average 5 – 12 days for the mastery of each of the n=7 vocals. AKU was the only participant who took 207 days to acquire n=7 vocals. Data on each acquired vocal are displayed in Figures 1.1-1.13 (Appendix 3).

Eleven participants namely, RRA, DSA, PGO, PNA, RPA, AKU, PPA, DSO, USE, SMO and ZMO acquired their first 7 vocals as mands under motivating operation conditions, while the remaining 4 participants AGU, RSA, NNA, and VKI acquired their first few vocals as echoic-mands suggesting initial acquisition under the control of vocal pairing presented by the therapist.

AGU (MBL 1.3) was included on the intervention at 1.5 years of age with a BLA score of 12. He was reported to be under medication due to a history of seizures. AGU was initially resistant to manual prompts, and would stiffen his hands if the therapist tried to touch him; this was observed in the initial week of the intervention. He was also unable to wait for preferred toys even for a few seconds resulting in screaming if he did not receive the toys quickly. In consideration of the above barriers, a slight modification was made in the independent variable during the first two weeks whereby all trials were conducted without manual prompting of signs. Any display of motivating operation was followed by pairing the target word without manual-signs, followed by the delivery of preferred item, and two more vocal pairings with 2-second delay. Once AGU allowed touching (which he did in two weeks) the protocol with manual sign prompts was re-instated. AGU met the mastery criteria by acquiring all seven vocals on day 46. All his initial 7 vocals emerged as phonemes i.e. /ba/, /da/, /fa/, /ja/, /ma/, and /la/ for bubbles, down- on the seesaw, fa-for blowing, jump, music and light toy. His six vocals were under multiple control of the motivating operation and the paired vocal except /ha/ which was an echoic. AGU went on to use words and acquired many skills to go to mainstream school with a facilitator.

While all the above children <3.5 years had the first instance of speech emerge before 23 days, the following 7 children namely; ANA, ASING, KSH, AUA, SMO, MAR, AAK (details provided in MBL 1.2, MBL 1.3, MBL 1.4, MBL 1.5, MBL 1.11, MBL 1.13) took longer to acquire their first vocal delaying further the interval of attaining the mastery criteria. For these children the earliest vocal emergence was noted after 87 days i.e. after a period of nearly 17 weeks of intervention. For most of these children, a majority of their vocals were acquired as independent mands i.e. their vocalization was not under the control of the paired vocal model and could have been a cause for the long interval of attaining mastery. ANA, KSH, and SMO acquired mastery criteria in 133 days taking an average 19 days/vocal while ASING, AUA, MAR, and AAK took 271, 385, 292 and 225 days respectively. During acquisition probes on echoic, tact and intraverbal conducted after each vocal acquisition, ANA and ASING repeated after the model on a maximum 2 presentations while none of the others did so. This affirms that the participants' vocals emerged were under the stimulus control of the motivating operations.

ASING was 1.7 years old and identified letters, numbers and shapes by pointing at them, and complied when these were presented which led to a BLA score of 14 during baseline assessment. ASING acquired vocals after 23 weeks at the age of 2 years with one echoic-mand; /see/ when he wanted to see the alphabet flash cards, and four independent mands; jump, open, hold and /aa/ for come. On acquisition probes conducted after the fifth vocal two echoics emerged to reach mastery criteria.

One of the outliers from this group, RDA took the longest period (706-778 days) to reach the criterion for vocal mastery. He had previously received IBI intervention. He was a 3.4 years old, quiet boy, rarely cried and was considered mute. While babbling and vocal production in the form of crying or giggling, strengthens vocal muscles enabling an infant to produce varied vocalizations (Schillingsberg et al., 2015) in the case of RDA, production of sound of any form was not observed over the long duration of his intervention. RDA never cried, and was a passive but happy child. RDA was on mand training with SSP for 141 weeks after which he emerged with vocals. The emerged vocal quality in the case of RDA, was phonemic and his first four vocals /cu/, /mu/, /ju/, /go/ for computer, music, jump and go, emerged as echoic-mands, under multiple control of the motivating operation and the paired vocal. His preference assessment identified a very limited set of preferences with his most preferred activity being ‘watching automated games on the computer’. Thus, it remains unclear what variables could have led to the long delays in vocal emergence for RDA.

Few participants (9 of 51) responded to the intervention after a long interval. Participants ASING, SMI, AUA, SMA, VPRI, RDA, SVEE, MAR, and AAK, took nearly 117-644 days for attaining the mastery criterion (Data provided on MBL 1.3, MBL, 1.4, MBL 1.5, MBL 1.6, MBL 1.8, MBL 1.11, AND MBL 1.13); of these 5 participants were <3.5 years of age and various factors such as maturation, stimulus over-selectivity, blocking, joint attention, could be variables requiring further exploration. For the remaining 4 participants, namely, SMI, SMA, VPRI and SVEE the long interval between introduction of the independent variable and the acquisition of vocals needs to be reviewed with caution. While significant individual differences was one factor, as no two participants on the autism spectrum were alike, the presence of comorbidities like low cognition cannot be ruled out as follow up data suggests a low learning rate and continuation of therapy. SVEE, MAR and AAK acquired 14, 14 and 11 signs respectively, prior to vocals. As independent signs were followed by delivery of preferred items paired with the first vocal, it is possible that signs had a blocking effect on vocal pairings causing delays. In these participants the effect of the intervention (i.e., stimulus-stimulus pairing) can not be ruled out entirely due to the fact that the vocals which emerged occured only under training conditions and they correlated with target mand words. Motivating operation and automatic reinforcement played a role as vocal emergence was not observed in any other situation.

Non-vocal participants

Participants KRD, HDE, AMO, SPR, SRA, AJOS, ARE, PKA, and SAM were on replication MBLs (1.3, 1.5, 1.7, 1.10, 1.11 & 1.12) respectively, and did not meet the criteria of vocalization thereby remaining non-vocal. Participant KRD was 2.1 years of age and remained on the intervention for 10 months. In the initial 3 months, he did not undergo the prescribed 40 trials of mand training and SSP, due to intensive crying when taken away from the computer where he preferred a particular cartoon sequence. Another barrier evident from his records was the presence of his mother in the play park area, where instead of exploring play equipments he preferred to be in his mother's lap. This suggests limited preferences and the presence of behaviors did not provide enough teaching opportunities. 4 participants namely, AMO, SPR, SRA, and ARE, spent 7-10 months on the intervention while PKA, AJOS, and SAM were on the intervention for more than 18 months. Other than KRD and HDE the remaining 7 participants were between 4.4-6.7 years of age with a minimum baseline assessment score of 12 (BLA). While protocols of mand training and SSP were implemented in the same manner, the reasons for these remaining non-vocal are unclear.

HDE was the oldest at 9.6 years of age. During the baseline assessment, HDE did not demonstrate any skills and received a minimum score of 13 of 60. He was unable to wait for preferred items, pulled at hand or engaged in high-pitched screaming for preferred items, had fleeting eye contact and could not identify objects, mand, tact or imitate. HDE was on sign-mand training with SSP for nearly 22 months and acquired 6 signs during this period. A follow up suggests he acquired a few motor imitations and learnt identical matching in 30 months of IBI suggesting a very low rate of learning. It is not clear if co-morbidities were part of his diagnosis, as another 13.5 years old participant Dako (MBL 1.0), described in details in Experiment 1, acquired vocalization on mand training and SSP. While both participants had similar BLA scores the individual differences were not evident and require comprehensive study.

Participants NPR and RKA (MBL 1.1) were both 5.6 years old females on single subject A-B designs. NPR had been previously attending special school and received a few years of speech therapy. She received a score of 16 (BLA) on the baseline assessment, and could perform some matching tasks and pulled assessors hand if she wanted something. She would cry loudly if the task continued longer than 7-10 minutes and disliked physical activity such as gross motor imitations. On introduction of mand training and SSP she achieved mastery criteria within one week meeting criteria. Vocalizations emerged as echoic-mands initially while the last 3 vocals were under the control of the motivating operations. RKA had a baseline assessment score of 12 (BLA), was not cooperative, had frail health, and often screamed producing a shrill sound. RKA acquired signs before vocal and acquired 4 vocals as echoic mands. On acquisition probes she filled in animal sounds meeting mastery criteria.

Summary

Experiment 1 and its replications demonstrate a large number (83%) of participants responded to mand training and SSP with nearly half the participants acquiring first instances of speech within 40 days of introduction of the independent variable. Some participants achieved mastery criteria quickly while some others had a long interval between the first vocal emergence and the seventh. There were 50% participants below the age of 3.5 years on the intervention, all except one benefitted from positive outcomes.

EXPERIMENT 2

Title: The emergence of vocals in non-vocal children with autism using delayed vocal stimulus presentation during mand training.

Introduction

The mand training protocol started with contriving a motivating operation (MO) for a preferred item or activity by bringing it in view but withholding access. The trainer then, prompted a sign, said the target word, and delivered the preferred item or activity (e.g., Bartman and Freeman, 2003). Experiment 1 in this study adds to the body of evidence in favor of sign mand training with 48 out 58 participants (83%) acquiring vocal verbal behavior. 10 children on this experiment however did not acquire vocals. The behavior analytic literature has demonstrated strategies for children who do not acquire vocalization even after several weeks of training. Errorless learning studies in behavior analytic literature have provided technologies to minimize errors while learning discriminated responding. These include stimulus shaping, response prevention, delayed prompting, super imposition with stimulus fading and superimposition with stimulus shaping (Maynard, Mueller, & Palkovic, 2007). Of these, time-delay procedures have been used to increase vocalizations in children with autism (Charlop, Schriebman, & Thibodeau, 1985; Halle, Marshall, & Spradlin, 1979; Matson, Sevin, Box, Francis, & Sevin, 1994). During time-delay varying temporal gaps were provided between presentation of a natural stimulus and response prompts to enhance the probability of stimulus control transferring from the prompts to the natural stimulus (Copper, Heron & Heward, 2007, p. 404). Time-delay procedures could use a constant time delay or a progressive time-delay. In both procedures, the first step would typically involve a zero-second delay between the natural stimulus and prompt in the first trial. In a constant delay procedure, subsequent trials would have a fixed delay of say 3 seconds. In a progressive time-delay procedure, the time-delay would be incremented by a certain number of seconds based on criterion met for pre-determined number of trials at previous time-delay level.

Touchette and Howard (1984) proposed that prompt-delay can produce errorless learning as they found that transfer of stimulus control from prompts to naturally occurring stimuli was accelerated when anticipatory responding contacted higher probability of reinforcement. Charlop, et al. (1985) used time-delay to increase spontaneous speech in autistic children. The participants were seven autistic boys of whom five could emit immediate and delayed echoics. Two of them had acquired vocal imitation with speech training. All the children could respond with 1 or 2 word responses but had very low spontaneous vocalizations and spontaneous manding. The participants were taught to mand using "I want __ (item name)" initially with a zero-second delay between presentation of an item and presentation of a model of the mand. After 3 consecutive successful trials with zero-second delay, a 2-second delay was introduced. If there was a request in this delay period it was immediately reinforced. 3 consecutive trials with correct unprompted responses led to an increment of the delay by additional 2-seconds until terminal 10-second delay was reached. Within 60 trials, all children achieved unprompted responding. Six children demonstrated response maintenance and generalization in 100% of the probe trials and the remaining one in 90%. The authors refer to hypothesis from prior studies that a failure of stimulus control to transfer from prompts to natural stimulus could be because of stimulus over selectivity seen in children with autism and learning disabilities. That is the students could be over selecting the prompts to respond to, instead of the natural stimulus. The successful transfer of stimulus control in Charlop et al. (1985) study could be attributed to the time-delay, which reduces the probability of over-selection of prompts.

Godby, Gast, & Wolery (1987) list more than ten studies (1971-1984) that demonstrated the usefulness of time-delay. These involved teaching communicative tasks such as manual signing, production of contextually appropriate vocalizations, requesting, and sight word reading. In addition, time delay, has also been successfully used, to teach bed making, assembly tasks, and visual discriminations. With 3 children having severe handicaps Godby et al. (1987) compared a procedure with least-to-most prompts, and time-delay while teaching spontaneous communication; and found that the latter involved fewer errors and fewer trials to criterion suggesting that time-delay can facilitate errorless learning better than a system of least-to-most prompting. The mand training protocol originally designed by Bondy and Frost (1994) in PECS training, incorporates time-delay in the 5th phase of the protocol to aid spontaneous communication drawing upon prior research with time-delay (Halle, Baer, & Spradlin, 1981).

Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet (2002) in their study to examine acquisition of PECS with 3 children with autism recorded an increase in spontaneous communication from 28% of trials in pre-training sessions to 100% post training with one participant, 0% to 83% with second and 2% to 68% with the third. The focus on mands in PECS training and the introduction of time-delay in phases 4 and 5 may have contributed to the increase in speech instances. Tincani (2004) and Tincani, Crozier, & Alazetta (2006) found increase in vocal responses when PECS was used with time-delay.

Carbone, Sweeney-Kerwin, Attanasio & Kasper (2010) used a time-delay in conjunction with sign-mand training. Three children with autism, with no functional vocal responding were taught manual sign-mand training. In their study, prompt delay was used for both behaviors, namely, manual sign and vocal prompt. The protocol involved contriving motivation for preferred items by bringing them in view but keeping them out of reach. A least to most prompting method was used and the participants were expected to use signs with or without vocals. The independent variable included prompt delay and vocal prompt. On declaration of motivation for an item, the participant made a manual sign after the preferred item was not delivered and instead a 5-second time delay was introduced. If the participant did not emit a vocal a vocal prompt was provided followed by a 2-second delay, if there was no vocal, the vocal prompt was re-presented twice. The preferred item was delivered on any vocal emergence or after the final sequence. Increases in vocal responses were seen across all three participants with this intervention.

This was the first study to incorporate a time-delay component in manual sign-mand training to specifically evoke vocalization. A time-delay could serve to increase the behavior-consequence salience and make responding more valuable to access reinforcement. The current study extends the Carbone et al. (2010) study with 3 children with autism who were non-vocal and had not acquired a single instance of speech, even after undergoing manual sign-mand training with paired vocals, for periods ranging from 9 to 33 weeks.

Method

Participants

Three boys with diagnoses of autism, Ashar, Akon and Hipal (names coded for confidentiality) aged 5, 4, and 5 years respectively participated in the study. All the children were enrolled in a 25 hours per week Intensive Behavioral Intervention Program (IBI) based on Applied Behavior Analysis (Baer, Wolf and Risley, 1968) and Verbal Behavior (Skinner, 1957). At intake, all participants were assessed using the Behavioral Language Assessment (BLA). After enrollment as non vocal with a diagnosis of autism, all the three participants Ashar, Akon and Hipal underwent manual sign mand training for varying periods; Ashar and Hipal for 33 weeks, Akon 9 weeks, with a minimum of 40 mand trials per day. During this period, none of them acquired a single instance of vocal behavior or speech though Hipal acquired 13 manual signs for manding and Ashar had acquired 3 sign mands. All three participants were enrolled into this experiment to see if introducing a delay in the auditory target stimulus during sign mand training can induce first instances of speech.

A pediatrician diagnosed Ashar when he was 2.5 years old. Prior to enrolling for behavioral interventions at an ABA based clinic in India, Ashar was receiving 27 hours of ABA based interventions per week from a center in the United States; from where his parents had relocated. In the BLA assessment; his abilities were scored at the lowest level 1 in 11 out 12 domains (co-operation, manding, vocal play, echoic, match to sample, listener responding, tacting, receptive functions, features and class, intraverbals, letters and numbers and social interactions). He scored slightly higher in motor imitation as he could imitate 8 gross motor movements. His BLA score was 13 out of 60 (Appendix 4). He would make guttural sounds that were not close to any syllables or phonemes and cry loudly for durations in excess of 15 minutes 4-5 times a day. His score on the Early Echoics Skills Assessment (EESA; Esch, 2008) was nil. The second participant, Hipal, was diagnosed when he was 2.6 years old by a pediatric psychiatrist at a leading mental health institution in southern India. He was enrolled in a special needs school and received occupational and speech therapy interventions before enrolling for behavioral interventions at age 5. At intake, his BLA score was 22 out of a maximum possible 60 (Appendix 4). He could comply with a few simple instructions, identify major body parts and imitate most adult gross motor and fine motor actions. He could write alphabets and numbers up to 20, but was not seen using writing to communicate, though opportunities were provided. He had rigidities in transitioning from preferred activities. He emitted no recognizable syllables or words and his vocalization was limited to occasional screaming. His score on the EESA was nil.

Akon, the third participant, was diagnosed with mild ASD and ADHD by a child psychiatrist and was on a prescription medicine called Sizodon on a dosage of 3 drops each in the morning and afternoon. Prior to intake, he was reported to be on speech therapy and sensory integration therapy for 45-minute sessions thrice a week in the preceding year. At intake, he scored 12 out of 60 (BLA, Appendix 4), and his EESA score was nil. Akon would be constantly moving and engaging in stereotypy such as picking up small leaves, dropping them and watch them fall. He would cry extensively and would not comply with instructions.

Response Definition, Measurement and IOA

The response definition, measurement, and mastery criteria required emergence of n=7, distinct instances of speech in this experiment as described in Experiment 1. Prior to the introduction of delayed-auditory-stimulus procedure, three probes were conducted on 6 preferred items across three days (Form 7, Appendix 1). The probes were conducted across mands, tacts, echoics and intraverbal fill-ins as detailed in Experiment 1. A second independent observer in all three-baseline vocalization probes confirmed non-vocal status of the participants. In the intervention phase vocal emergence of target vocal for 5 consecutive days led to an inter observer agreement by a supervisor and therapist on 5 acquisition probes (Form 12, Appendix 1) recreating the relevant stimulus conditions for each acquired instance of speech for each participant. The inter-observer agreement was then calculated as the number of agreements divided by total number of probes multiplied by 100. There were all-inclusive 35 probes per participant, i.e. 5 probes for each of the 7 acquired vocals conducted during intervention. If the IOA for any vocal was below 80%, the instance of speech was not deemed acquired and the probe data was discarded and training with delayed-auditory-stimulus presentation during mand training continued until an IOA of at least 80% was recorded. Further, on acquisition of any instance of speech, vocal acquisition probes for tacts, echoics and intraverbals were conducted and IOA measured. The inter observer agreement for Ashar, Hipal and Akon was 100%, 94% and 97% respectively and the mean IOA for this experiment was 97% (Range 94 - 100%).

Stimulus Preference Assessment

Participants on the study were previously undergoing sign-mand training with stimulus-stimulus pairing and targets were derived from the preference assessment procedures described in Experiment 1. For this study, prior to introduction of the independent variable additional preference assessments were conducted. This included a five-minute brief preference assessment (Carr, Nicolson & Higbee, 2000). Eight stimuli selected from previous detailed preference assessment; were presented thrice and ranked in order of preference. The 6 top ranked stimuli edibles/tangible items or actions were selected for training on this intervention (Table 9). Each participant had an array of 6 highest preferred edibles, toys and activities that were undertaken for training.

Table 9: List of preferred stimuli for Experiment 2

Participant	Preferred Items	
Ashar	Toys: Outdoor: Edibles:	Toy, Blocks, Baloon, Music on Computer Swing, Merry-go-round, Slide, Trampoline Biscuit, Chips
Akon	Toys: Outdoor: Edibles:	Toy, Spoon, Spring toy Merry-go-round, Gym-ball French-fries, Grapes, Candy
Hipal	Toys: Outdoor: Edibles:	Ball, Music on Computer, Toy, Block, Bubble Swing, Merry-go-round, Trampoline Biscuit, Chips

Experimental Design

A multiple baseline across subjects was used. The design involved introducing the intervention for the next participant after the previous participant acquired at least one instance of speech.

Procedure

Baseline

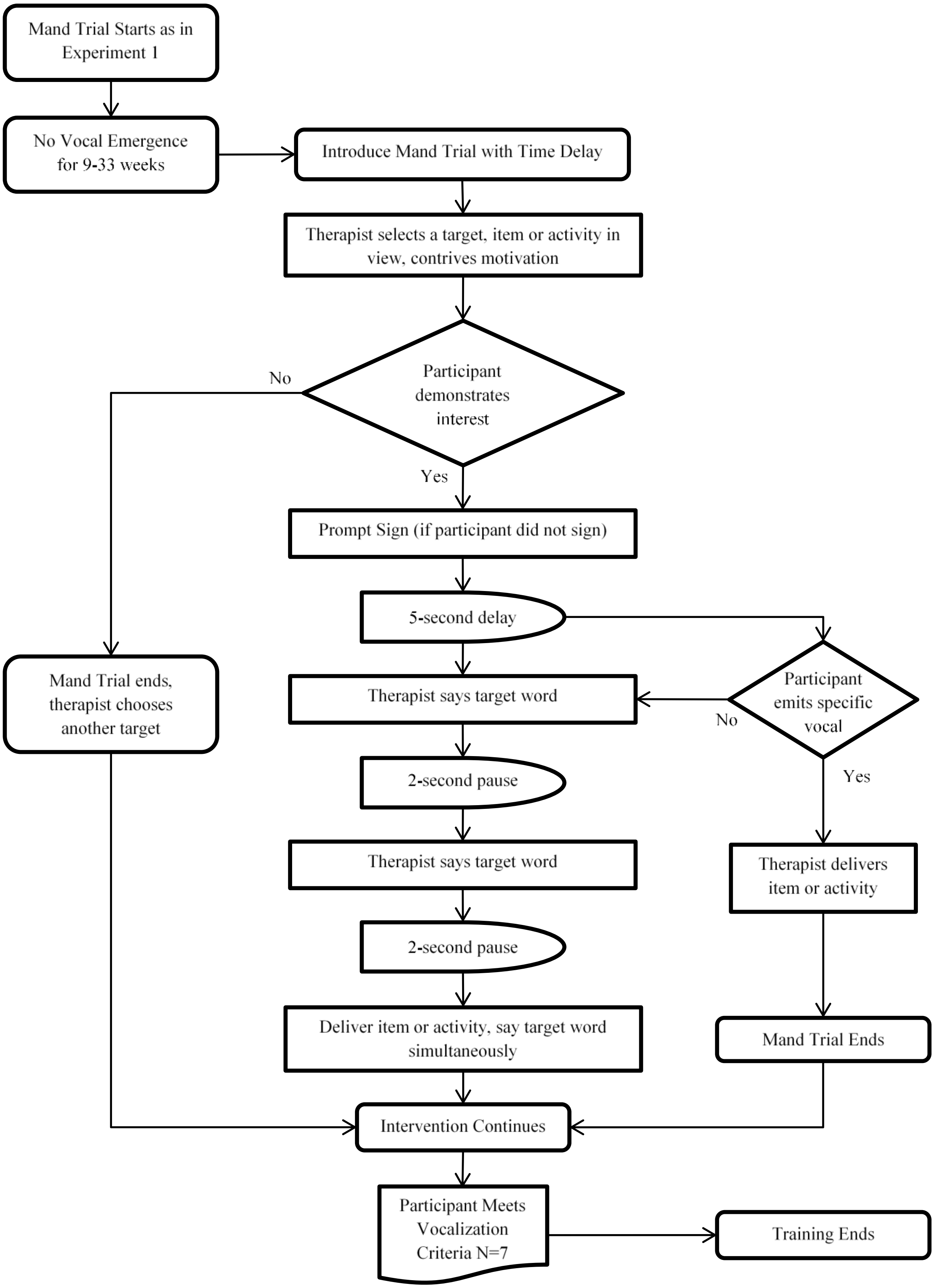
Prior to introduction of the delayed-auditory-stimulus condition baseline probes were conducted for vocals as described in Experiment 1.

Mand Training with Delayed-Auditory-Stimulus Presentation

In the current study, the independent variable (Flow Diagram 2) was applied to 6 target items or activities that were selected post brief preference assessment. When the current independent variable was applied, the previous protocol was halted. The therapist brought a targeted item in view at eye level of the participant but kept it out of reach or took the participant close to a preferred activity area such as near the swing or the computer from which music videos could be played. If the participant declared motivation by reaching out or looked at the relevant stimulus or at the therapist without emitting the corresponding sign or a specific vocal, the therapist prompted the sign and introduced a time-delay of 5-seconds after the completion of the sign and presented a vocal auditory target word. In the event the participant did not vocalize two additional vocal sounds were presented with a 2-second pause each, at the end of which the preferred item was delivered simultaneously pairing the target word. If at any time during the initial 5-second time-delay or during subsequent 2-second pauses, the participant emitted a specific vocal the reinforcer was delivered immediately and the trial was ended. Thus the participant was presented a total of 3 opportunities to vocalize with a maximum 9-seconds before delivering the preferred item. In the first opportunity of 5-seconds, there could be emission of specific vocal under the control of relevant motivating operation. In the two subsequent 2-second pauses there was an opportunity to emit a specific vocal under the joint control of motivating operation and adult auditory vocal.

If the participant did not emit a specific vocal even after the presentation of the auditory stimulus, after the final 2-second pause, reinforcement was delivered paired with the target word ending the trial. This is represented as follows.

Flow Diagram 3: Sign Mand Training With Delayed Vocal Prompt Procedure



Participant demonstrates motivation for an item however does not sign. Therapist prompts sign → 5 sec delay → therapist says target word → 2 sec delay → therapist says target word → 2 sec delay → therapist says target word and delivers preferred item simultaneously. If no motivation for the item or activity could be ascertained the trial was terminated and the participant was transitioned to another activity or presented preferred items of the remaining 6 targets to ascertain motivation before proceeding for training. Each session consisted of 40 trials of delayed-auditory-stimulus presentation.

Treatment Integrity

During intervention, the supervisor as an independent observer observed 100 trials in the first week of intervention. All 6 mand targets selected were observed equal number of times. If the score was less than 80% after one week, the intervention was paused and re-training provided to the therapist until he/she was able to demonstrate competence in mock trials with supervisor. For all therapists in this study such a contingency was not contacted during treatment integrity checks as they consistently scored 80% or more. Thereafter treatment integrity checks were conducted for one trial per target per month for each participant. The supervisor scored each trial of each therapist on the following components of the independent variable. A) Identified relevant MO and ascertained motivation B) Prompt the sign if required C) Pause for 5-second D) If there is no vocal, present the target word, pause 2 seconds, present the target word again, pause 2 seconds E) Deliver reinforcer pairing the target word. Yes/No data was taken after each trial, and transcribed, on vocal emergence (Table 9.1). For a trial the score could range from 0 to 5 and if 100 trials were observed the maximum possible score would be 500. Treatment integrity scores were calculated for the observation period as follows:

$$\frac{\text{Actual score}}{\text{Maximum possible score}} \times 100$$

After the first week, treatment integrity checks were conducted for one trial per target, per participant, per month; to ensure integrity of the independent variable was maintained. Integrity of implementation of the independent variable for the study was 90% (Range 83% to 93%) presented in Table 18 (Appendix 2).

Table 9.1: Mand Training with Time-Delay TI Component Skills

S.No	Component Skills	Mark
1	Ascertained Motivation prior to teaching trial	Y/N
2	Prompt the sign if required	Y/N
3	Paused for 5-seconds	Y/N
4	Present the target word, pause 2-sec, present target word, pause 2 seconds	Y/N
5	Deliver reinforcer paired with target word	Y/N

Results

During baseline probes, none of the participants emitted any vocalization under stimulus control. Previous training using mand training and SSP lasted for 33 weeks, 9 weeks and 33 weeks respectively for Ashar, Akon and Hipal and none of them acquired any specific vocal as a mand, echoic-mand, tact or intraverbal. On introduction of the delayed-auditory-stimulus protocol during mand training, all participants emerged with vocals as depicted in Table 9.2.

Table 9.2: Weeks to Vocal Emergence – Expt. 2

Name Code	Weeks to 1st Vocal	Weeks to 7th Vocal
Ashar	1	7
Akon	3	11*
Hipal	9	13

* Excludes a 8 week break from intervention

Ashar started emitting the specific vocal /biss/ for biscuit on the very first session and met the mastery criterion for vocal mands in 5 days. He went on to acquire 6 additional vocals (Table 9.3) under conditions of MO in the next 7 weeks. These were /pus/ (for adult to push him when on a swing), /mu/ for music to see a film dance song on the computer, /tu/ for toy, /chee/ for chips, /ba/ for balloon and /sss/ for slide . Despite having some motor imitation skills in his repertoire, he had not acquired the signs for these highly preferred items but was able to emit the specific vocal approximations under the control of MO and the delayed-auditory-stimulus protocol.

Table 9.3: Ashar Vocal Emergence Data

Target Word	Vocals Approximation	Days to Vocal	Operant
Biscuit	Biss	5 days	M
Push	Pus	6 days	M
Music	Mu	8 days	M
Toy	Tu	11 days	M
Chips	Chee	21 days	M
Baloon	Ba	26 days	M
Slide	Sss	30 days	M

Once Ashar achieved 4 vocals, the independent variable was introduced for Akon, the second participant. Akon started emitting vocals and acquired two vocals, /ta/ for toy and /fie/ for fries in the third week of intervention meeting criterion. Thereafter he did not gain any additional vocals in the next 4 weeks and proceeded on an 8-week holiday. When the interventions resumed he had maintained the previously acquired vocal mands however certain other interventions had to be introduced to address challenging behaviors that had emerged in the interim such as extensive crying and a very low rate of attending to instructions. In 4 weeks, he acquired 5 additional specific vocals within one week. Two were mands, /bunce/ for bouncing on the gym-ball and /spun/ for spoon. Since acquisition of any vocal also triggered probes for echoic tacts and intraverbals, 3 instances of intraverbal responding emerged in this week. These were /o/ as an intraverbal fill in response to the stimulus “Old McDonald had a farm, eiya, eiya”, /stah/ as an intraverbal fill in for the verbal stimulus “twinkle, twinkle, little”, and /papa/ as an intraverbal response to the verbal stimulus “johnny-johnny, yes” (Table 9.4). After Akon had acquired the first two vocals and since he was proceeding on a long leave, the intervention was started with Hipal.

Table 9.4: Akon Vocal Emergence Data

Target Word	Vocals Approximation	Days to** Vocal	Operant
Toy	Ta	23 days	M
Fries	Fie	23 days	M
Bounce	Bunce	21 days	M
Spoon	Spun	21 days	M
Oh	O	21 days	IV*
Star	Stah	21 days	IV
Papa	Papa	21 days	IV

*IV=Intraverbal **Excludes the 8 week break from intervention

Hipal was added as a third participant on the study later than Akon as his pre-requisites for waiting for 5-seconds were on target. Hipal acquired the first vocal in week 9 after introduction of the delayed-auditory-stimulus and in the following 4 weeks acquired 6 additional vocals as mands under the control of MO. These were /mo/ for "move" when he wanted the experimenter to move away from the video screen, /ow/ for going out to the play area, /su/ for "show" when a music video screen was turned blank, /boh/ for ball, /bu/ for biscuit, /mu/ for music and /sss/ for swing (Table 9.5).

Table 9.5: Hipal Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal	Operant
Move	Mo	43 day	M
Out	Ow	49 days	M
Show	Su	55 days	M
Ball	Boh	59 days	M
Biscuit	Bu	62 days	M
Music	Mu	63 days	M
Swing	Sss	63 days	M

In the follow up assessments conducted on week 30, Ashar, Akon, and Hipal had acquired additional vocals taking their total vocal repertoire to 32, 24 and 56 respectively. Ashar acquired 12 vocal mands, 6 intraverbal fill-ins and 14 echoics. Most of his vocals continued to be vocal approximations such as saying ‘doe’ for no, ‘wa’ for water, ‘apah’ for apple, ‘koh’ for chocolate however they were consistent and generalized. His EESA score at 30 weeks was 14/100.

Akon acquired 13 mands and 11 intraverbal fill-ins. He could articulate initial sounds of each target words like ‘joo’ for juice, ‘wa’ for water, ‘o’ for open. He could articulate the /st/ and /sp/ blends however not the /fr/ blend. His EESA score was 15.5/100.

Hipal acquired 16 mands, 7 tacts, 8 intraverbal fill-ins and 25 echoics by week 30. When asked to label adjectives he labeled /fee/ for few and /ma/ for many, /kah/ for cup, /bue/ for blue colour. When filling intraverbals he vocalized /ba/ when asked dog says as well as sheep says. Hipal had an EESA score of 17.5/100 at week 30.

Discussion

In this study, a delayed-auditory-stimulus presentation resulted in emergence of vocalizations in 3 non-vocal children with a diagnosis of autism. This study extends previous research by Carbone et al. (2010) with slight modifications in time-delays. The current study demonstrates this with a small set of data; it suggests that delayed-auditory-stimulus presentation can be a procedure which can be considered useful for children with autism, who have severe speech delays and have not demonstrated improvements, despite exposure to a variety of interventions including speech therapy. The intervention embedded within sign-mand training with stimulus-stimulus pairing provides an opportunity for learning communication, while pairing target words under conditions of motivating operations.

The almost immediate emergence of vocals, in the delayed-auditory-stimulus presentation condition, within a week for Ashar and Akon adds to the evidence favoring the introduction of time-delay. Hipal had a long history of interventions including speech therapy and had previously been on mand training with SSP for 33 weeks. He was mute and emerged with vocals within 9 weeks after the time-delay procedure was introduced, under conditions of motivating operations.

One of the reasons for the delayed-auditory-stimulus procedure being effective as compared to a procedure without the delay could be that variability in behavior is induced in the delay period when reinforcement is withheld (Esch, et al., 2002). During mand training with stimulus-stimulus pairing, there was only a 2-second delay, and it may be possible, that the participant could either wait out or not attend to the therapist, as access to the preferred item was provided within a short span. Due to an already existing repertoire of sign-mands, it may be concluded that Hipal had built a reinforcement history for using sign mands and when access to reinforcer was delayed, this evoked new behaviors and time-delays led to vocal emergence. The results in this experiment serve as a systematic replication of findings from Carbone et al. (2010) in which the independent variable was replicated except for two modifications. In the current experiment the vocal model after the initial sign was presented at 5 sec-2 sec-2 sec (9-sec) delay in comparision to 5sec-2sec-2sec-2sec (11-sec) delay in Carbone et al study. The second modification in the current study included presentation of desired item immediately after any vocal emergence as compared to the repetition of trial if manual-sign did not precede vocal.

For Ashar and Hipal all vocals emerged as independent mands and were approximations of target words. Akon also emerged with vocal approximations; and acquired two mands prior to his break, and two mands post break, however, after the 4th vocal emergence, on acquisition probes he emerged with 3 intraverbal fill-ins within the same week. This suggests vocalizations generalized across operants due to possible exposure to rhymes learnt from videos or other environments. Such possibilities need to be explored further.

Anecdotal reports indicated that when a mand trial without the delay procedure was implemented for a highly preferred item, Ashar would screw his eyes shut and turn his head away. When the therapist said the item name the third time, at the point reinforcer delivery would occur, he would snap his head back into position and get ready to receive the item. By using time-delays in auditory-stimulus presentation, Ashar’s behavior of opening his eyes predictably was challenged, and this behavior followed extinction. This led to improvement in attention towards the therapist resulting in vocal emergence within the first week of using the independent variable. Ashar had not acquired any signs, and was provided manual guidance for communication, hence the predictable delivery of the reinforcer did not occasion any effort from this participant. This study validates previous studies on the effectiveness of time-delay where a 15-sec & 10-sec time delay by Halle et al. (1979) and Ingenmey and Van Houten (1991) respectively resulted in speech in three children with intellectual disabilities and improved spontaneous communication in a child with ASD. This suggests that increasing the waiting time from 2-sec during time-delay to 9-seconds with time-delays in the current study could evoke vocal behavior in some children

In the study by Carbone et al. (2010), if a participant emitted a vocal response without sign during the initial prompt delay, the therapist would still complete the prompt for the sign and only then, start the 5-second delay for the auditory stimulus presentation. This was necessary to ensure that, signing as a mode of communication remains in focus. In this study, all the participants except Hipal went on to learn communication-using vocals without acquiring sign mands. Hipal acquired 12 sign-mands, prior to the delayed-vocal-stimulus intervention and used those signs for requesting specific items or actions for which he had not yet acquired vocal mands. However, as the vocals for all the three participants emerged as approximations of target words, it was necessary to continue with sign mand training, until vocals acquired had enough clarity to provide the speaker reinforcement from the environment.

Limitations of the study include limited generality as the intervention was applied on only 3 participants. Further, while generalization was evidenced across operants the same was not systematically tested across settings such as home and school.

Figure: 2.0 Experiment 2

Effect of introducing time-delay during mand training with SSP

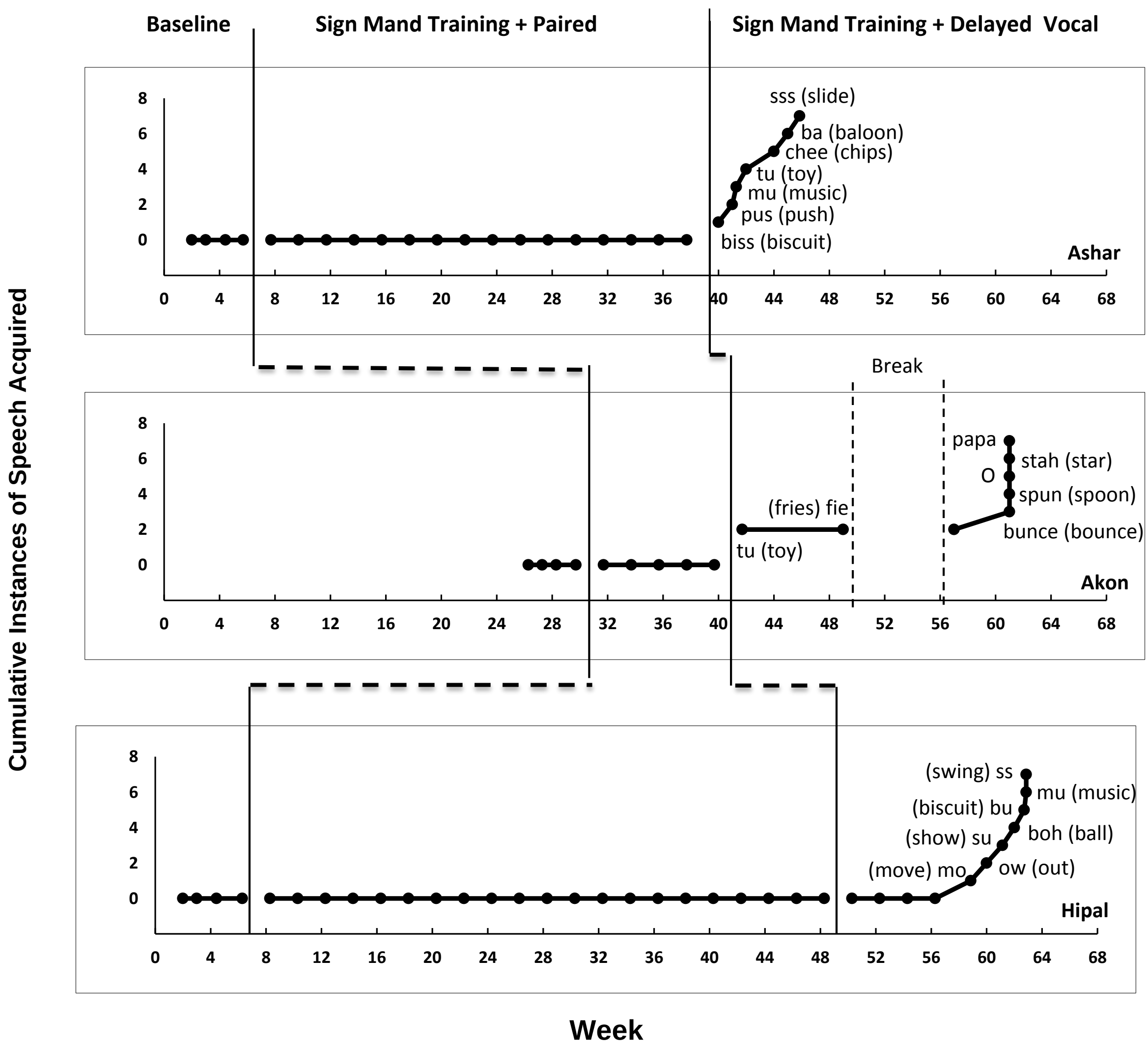


Figure 2.0: A multiple baseline across subjects to study the effect of delayed vocal auditory stimulus on acquisition of speech by children with autism undergoing sign mand training.

EXPERIMENT 3

Title: The role of intraverbal training with paired stimulus in inducing first instances of speech in non-vocal children with autism when stimulus-stimulus pairing during mand training is ineffective.

Introduction

Studies on intraverbal training have established a new repertoire of language development through intraverbal responses such as storytelling (Valentino, Conine and Delfs, 2015), reverse intraverbals (Allan, Vladescu and Kisamore, 2015), bi-directional intraverbals (Dounavi, 2014), yes- no responding (Shillingsburg, Kelley, Roane, Kisamore & Brown, 2009) and complex intraverbal responding (Sautter, LeBlanc, Jay, Goldsmith & Carr, 2011). Several studies have also focused on the variables impacting intraverbal acquisition (Coon & Miguel, 2012; Finkel, Williams, 2002; Grannan & Rehfeldt, 2012; Ingvarsson & Hollobaugh, 2011; Valentino, Shillingsburg & Call, 2012).

A review of titles in the journal the Analysis of Verbal Behavior published between 2010-16 reveals no studies that have explored the role of intraverbal training in the emergence of speech in non-vocal children with autism. Sundberg and Partington (1998) describe several procedures for teaching beginning intraverbal skills, to children with autism and other learning disabilities, using fill-in opportunities in songs, rhymes, animal sounds, object sounds, common associations and specific daily activities.

Experiment 3 examines 46 participants between ages 1.11-12.2 years; each participant previously on mand training with SSP for an average 12-52 weeks and not acquiring a single instance of speech. The purpose of this study was to study the effect of the addition of a second independent variable: i.e. a verbal unit paired with target vocal (intraverbal fill-in) in inducing first instances of speech in children who remained non-vocal. Each participant was randomly assigned on a delayed multiple baseline. Each MBL had 3-7 participants distributed across 10 MBL studies. The following section discusses findings on 4 male and 1 female non-vocal participants on one multiple baseline design (MBL 3).

Method

Participants and Settings

Five children, Reyan, Neha, Barry, Mahar and Ricky (names changed) with a diagnosis of autism as per the sample selection criterion, participated in this study. Each participant was specifically selected as each had undergone 27-42 weeks of manual sign-mand training with SSP and had not acquired a single instance of speech. All participants except Barry underwent 25 hours/week intervention at the center while Barry attended training for 10 hours/week. All five participants were enrolled on this experiment to study the effect of introduction of intraverbal training as an additional variable and on vocalization while the sign-mand training with SSP was continued. Sessions were held at the tabletop and natural environment as explained in Chapter 9.

Reyan was 1.11-year-old boy at intake. He was a cheerful child and would rarely cry. As an infant he did not allow physical prompting and did not sit on a chair for more than a few seconds. Prior to the intervention in Phase 1 with sign-mand training, his BLA score was a minimum 12 of 60 and his score on EESA subtest was nil. Reyan was selected for participating in this study after 28 weeks of being on mand training with SSP without vocal emergence. Just prior to the introduction of intraverbal training, the BLA assessment was conducted again. Reyan's BLA score improved to 22 of possible 60 (Appendix 4). He demonstrated improvements in pre-requisites to learning. He was more cooperative, started allowing manual guidance for prompting, sat on the chair longer, played with a variety of toys, and maintained eye contact during mands and instructions. He acquired 12 sign mands (swing, slide, chips, jump, bag, out, go, up, chocolate, water, open and book), which he used independently. He could receptively point at 4 body parts, 3 environmental objects by walking to them from 6 feet, respond to 3 contextual verb actions like kick the ball. He had mastered three one step instructions like clap hands, and acquired 10 gross motor imitations, and 2 imitations with objects in the intervening period. He did not respond to oral motor imitations and did not echo when asked. No vocal play was observed either. His EESA score was nil.

Neha was 3.6 years old girl at intake. She would grab preferred items and not give them when asked. Her eye contact with adults occurred only 20% of the instances of a motivating operation being present or an adult presenting instruction. Her compliance with even simple adult instructions was poor. She did not sit on instruction and her sitting at the table was dependent on the value and type of preferred items. Neha did not respond to instructions when reinforcers were held in view. She scored 13 on the BLA assessment at intake. Her EESA scores were at nil and she was non-vocal. She would shout and scream when access to preferred items were delayed by 3-5 seconds. She was included in this study after being on mand training with SSP for 32 weeks. Prior to beginning on the intraverbal training her BLA scores were 21 of a possible 60 (Appendix 4). She cooperated for few instructions with slight delays in reinforcement delivery. She acquired 9 sign-mands and developed a strong imitation repertoire and could respond to imitation models on gross motor imitations, imitations with objects and 3 fine motor imitations however did not respond to oral motor imitations. On receptive language, she acquired 4 body parts and 11 one step instructions. On visual performance, she could match a few identical objects in an array of 4 and matched shapes in a form box. Her EESA score however continued to be zero.

Barry was a 3.2 years old boy who scored 12 on BLA assessment with no vocal imitation and zero on EESA at intake. He emitted escape behaviors when any demands were placed, made no eye-contact with adults and would grab preferred items rather than use more appropriate ways for accessing them. He would flop down on the floor when denied preferred items, and was undergoing speech therapy, occupational therapy, and training on other skills with a special educator as per parent reports. He was included on this study after 42 weeks of being on sign-mand training with SSP. Prior to introduction on this study his BLA score was 20 (Appendix 4). He had acquired 1 sign-mand and followed a model on 3 gross motor imitations. He could match 3 identical objects in an array of 3 and inserted a circle in the form box. On receptive language he had mastered 1 body part, 3 one step instructions, 2 actions in context and walk to a swing from a distance of 2 feet to identify it. His EESA score was nil and he was non-vocal.

Mahar was 3.2 years old boy at intake and had a BLA score at the minimum possible 12 with an EESA score of nil. He did not make eye contact with adults while requesting or when an adult addressed him. He was a quiet child however did not cooperate by sitting. His motor stereotypy interfered with his learning, as he would hand flap. He was on mand training using SSP for 30 weeks, before his introduction as a participant on the current experiment. Prior to his introduction his BLA score had improved to 20 on account of gains in requesting (Appendix 4). He acquired 4 sign mands (slide, jump, massage and biscuit), imitated with objects when a model was presented, could match a few identical objects, pictures and non-identical objects during visual performance tasks, and learnt to point at 2 body parts and kick a ball when instructed. His EESA score was nil and he was non-vocal.

The final participant on this experiment was Ricky, a 3.2 years old boy, whose BLA score at intake was 12 of a possible 60. He was non-cooperative, and exhibited no eye contact. He grabbed things he wanted, and would climb on or slip under furniture, did not demonstrate any skills in imitation, echoics, visual performance, or receptive language. He was dependent for self help skills. His EESA score was nil. He was on mand training with SSP for 27 weeks and continued to remain non-vocal. He underwent another BLA assessment before he participated on the current multiple baseline study as the fifth participant. Prior to beginning on the current study his progress continued to be very slow. He acquired 2 sign-mands however his observing response under both mands and during instruction was negligible. His sitting span was less than 2 minutes and his attention to activities was less than 30 seconds. He was prompted for all tasks, such as, imitation, or receptive language targets like one step instructions, body parts, and contextual instructions. He did not respond when called by name. He had not acquired any imitation skills like following the model to complete a motor action with object or imitate gross motor action of model. His BLA score was 16 (Appendix 4) and his EESA score was nil while he continued to be non-vocal.

Response definition, Measurement and Inter Observer Agreement

As in previous studies, the dependent variable in this study too was the emergence of n=7 distinct instances of speech as per mastery criterion described in Chapter 9. Phase 1 of this study was conducted during conditions of motivating operation with sign-mand training and SSP as detailed in Experiment 1; while Phase 2 included intraverbal training for rhyme fill-in, animal sound or fun fill-in. Acquisition of an instance of speech was recorded during Phase 1 and 2 as well as during acquisition probes conducted for mand, tact or echoic responses as described earlier.

At intake baseline probes were conducted on mands, tacts, echoic and intraverbal fill-ins, on three successive days to assess if participants could emit vocals under stimulus control as in Experiment 1. A second observer independently recorded the emission or non-emission of vocals for each probe in baseline, and there was 100% agreement on absence of speech for all the participants.

During Phase 1 of mand training with SSP, the baseline and cold probes were conducted, as described in Experiment 1. A second observer recorded data during probes independently, and ascertained measurement of the dependent variable (Form 7, Appendix 1). Baseline agreement on absence of any instance of vocal-verbal behavior was 100% on mands, tacts, echoics and intraverbals. Daily cold probes were conducted during sign mand training with SSP, and a second observer collected data, every 2 weeks, on each target mand trial.

In Phase 2 of the study, prior to introduction of the intraverbal training, baseline probes were conducted for intraverbal fill-ins as well as mand, tact and echoic probes (Form 7, Appendix 1) by two independent observers. Baseline probes for each participant showed 100% IOA on non-vocal status of each participant, confirming his or her participation in the next phase of the study. During intervention; the therapist on relevant antecedent verbal unit conducted cold probes, daily, i.e., on 3 selected targets, and 6 mand targets. The occurrence of a specific vocal for 5 consecutive days triggered a probe on relevant stimulus, by a second observer. An acquisition probe was conducted on Form 12 (Appendix, 1) across mands, tacts, echoics and intraverbals. Vocal emergence was recorded “yes” if a specific vocal was emitted by the participant without any prompt. Agreement on the presence and type of vocal along with the operant unit under which vocal emerged was recorded. An agreement of 80% or more resulted in declaring acquisition of the specific vocal. Thus, for each participant, for each of the first 7 instances of speech, 5 acquisition probes were scored by the therapist and supervisor independently and IOA calculated. The IOA scores on vocals emerged for Reyan, Neha, Barry, and Mahar were 86%, 91%, 94%, and 86% respectively. The Mean IOA for this experiment was 89% (Range 86% to 94%). Mean IOA was less than 100% mainly due to the difference in the exactness of the vocal noted by both observers.

Stimulus Preference Assessments

Preference assessment was conducted twice during the experiment; once, before Phase 1 of the experiment, to identify items of high value for selecting targets, for mand training. The procedure used was identical to that in Experiment 1. A second preference assessment was completed before Phase 2. Items identified during this assessment were used as reinforcers during the experiment. To ensure ease of reinforcer delivery, tangible and edible items were chosen to function as reinforcers however play activities and park equipment were also identified as reinforcers. A list of 8-15 items was identified through a MSWO procedure (DeLeon & Iwata, 1996) as well as free operant preference assessment (Ringdahl et al, 1997). To control for day-to-day variations in strength of preferences the therapist presented all the items in an array and selected the first three items touched by the participant as reinforcer (Miliotis et al. 2012), during intraverbal fill-in training trials on that day. Brief preference assessments (Carr, Nicolson & Higbee, 2000) were conducted intermittently during mand training. A comprehensive list of preferred items selected for each participant is in Table 10 below.

Table 10: List of Preferred Items

Participant	Preferred Items
Reyan	Piano, Xylophone, Rocking horse, Books, Play-doh, Slime, Music-Rhymes of computer, Biscuit, Chips, Chocolate, Kurkure, Trampoline, Slide, Merry-go-round
Neha	Light Toy, Rainmaker, Book, Puzzle, Crayon, Musical toy, Bubbles, Chocolate, Kurkure, Swing, Trampoline, Slide, Sand
Barry	Bubbles, Book, Puzzle, Toy, Music, Biscuit, Chips, Juice, Sweets, Tickle, Rhymes on computer, Swing, Trampoline
Mahar	Bubbles, Biscuit, Light toy, Top, Music on computer, Swing, Xylophone, Mechnical toys, Spinners, Sand pit (digging), Play doh
Ricky	Chips, Chocolate, Kurkure, Juice, Toy, Bubbles, Crayons, Swing, Ball, Trampoline, Merry-go-round, Sand pit (digging)

Experimental Design

A concurrent multiple baseline design was used across 3 participants, with 2 participants joining the study later as the previous participant on the MBL acquired a minimum of one vocal.

Procedures

Baseline

Prior to introduction of the independent variable in Phase 1 and Phase 2, probes were conducted as described in detail in experiment 1. Probes ascertained the non-vocal-verbal status of Reyan, Neha, Barry, Mahar, and Ricky, the 5 participants.

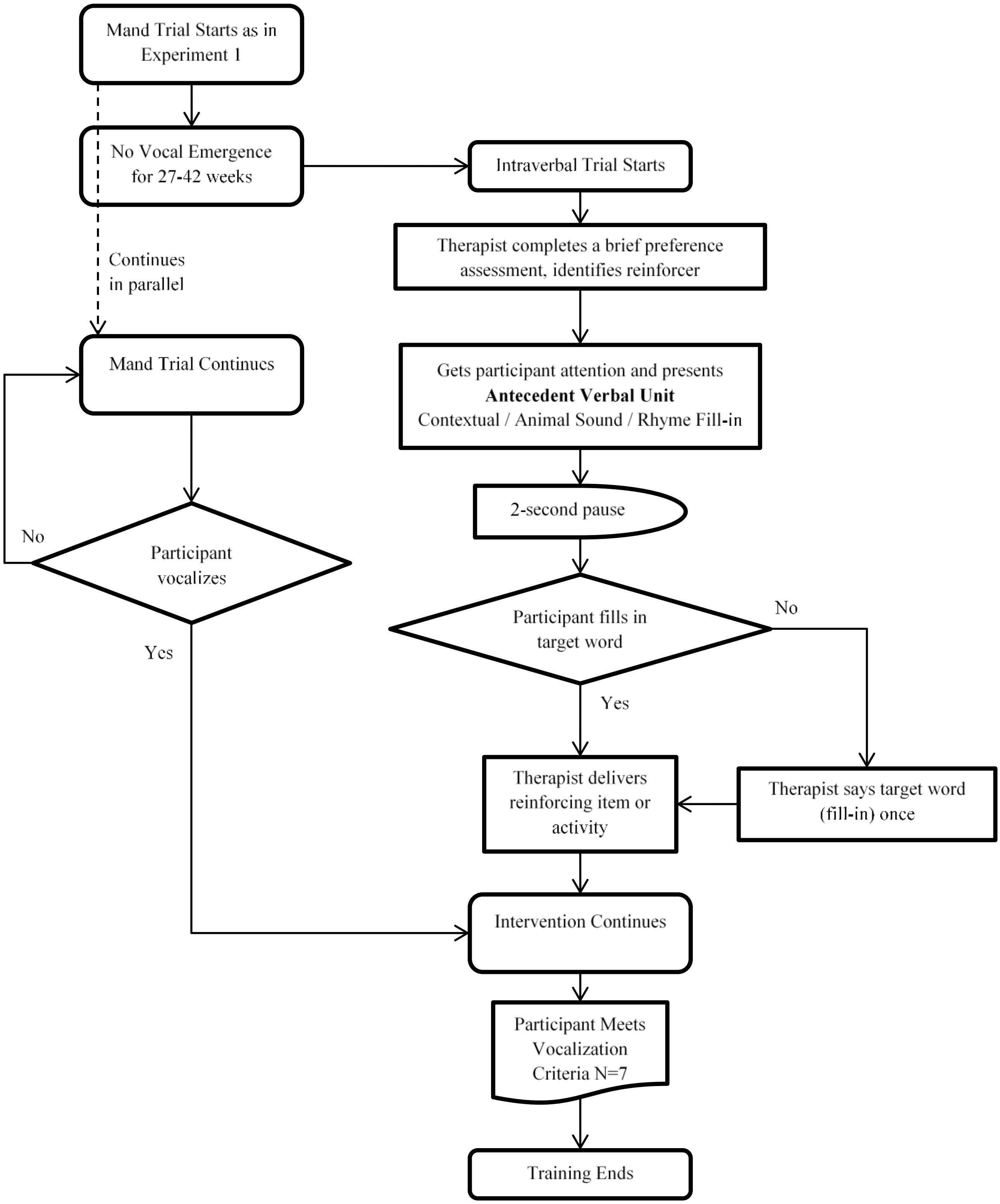
Mand Training using Stimulus-Stimulus Pairing

The procedures (Flow Diagram 1, 3) here were identical to those in Experiment 1.

Intraverbal Training

Intraverbal training a second independent variable (Flow Diagram 3) introduced in Phase 2 required a verbal response without point-to-point correspondence to an antecedent verbal stimulus unit (VU). For each participant, 3 targets were selected, one each from the categories of rhyme fill-in, fun fill-in and animal sounds. The therapist presented the antecedent verbal unit (VU), paused for 2 seconds, and paired target fill-in word with simultaneous presentations of preferred tangible. The first category involved singing a nursery rhyme with a lot of enthusiasm and appropriate variations in tone and pitch till the target word at which point the trainer paused for 2 seconds; for example while singing “Johnny-Johnny yes papa eating sugar, no” the trainer paused for 2 seconds and filled the target word “papa”. In this example the rhyme sung by the therapist “Johnny-Johnny yes papa, eating sugar no” was the “verbal unit” (VU) and the target word after the pause “papa” was paired with delivery of reinforcer. The target word “papa” was paired only once with each “verbal unit” presentation. A second type of antecedent verbal unit included filling in animal sounds. The trainer would present the “verbal unit”, “dog says” pause for 2-seconds and pair the target word “bow-bow” with reinforcer. The above two pairings were done at the tabletop. A third type of intraverbal pairing was taught in natural environment. Here the trainer would create a situation such as getting ready to run or getting ready to spin the merry go round and

Flow Diagram 4: Mand Training and Addition of the Intraverbal Training



begin with “one…two…” pause 2-seconds, and pair the target word “three” with reinforcer. There was only one pairing of the antecedent verbal unit with the reinforcer.

Integrity of the Independent Variable

A supervisor assessed integrity of both the independent variables during training. The therapists were observed on specific training components for mand training as described in Experiments 1 and intraverbal training as described below. In the first week of each intervention, 100 mand trials across 6 selected mands, and 50 intraverbal trials across 3 selected intraverbal targets, were assessed for each therapist and participant. Thereafter, treatment integrity was assessed for one trial each, per mand and intraverbal target per month. If on any evaluation day the trainer scored less than 80% the intervention was paused for a couple of days until the therapist could demonstrate competence in mock trials with the supervisor.

During this experiment, a second independent variable of intraverbal training with paired vocal was introduced while mand training with SSP continued. Treatment integrity checks for mand training, continued as described in previous experiments, and were a mean of 88% (Range 57 – 100%) for this experiment.

On introduction of the second independent variable, the therapists were observed on the following component skills. A) get participant attention B) present the correct antecedent verbal unit, C) pausing for 2 seconds D) presenting the target word and E) delivering a preferred tangible or activity.

Table 10.1: Intraverbal Training Component Skills

S.No	Component Skills	Mark
1	Get attention	Y/N
2	Present the antecedent verbal unit	Y/N
3	Pause 2 seconds	Y/N
4	Present the target word	Y/N
5	Deliver appropriate consequence	Y/N

Thus for a trial, the score could range from 0 to 5. As per previous experiments for each participant, the supervisor observed 50% trials across the first week. The maximum possible score would be 50 and treatment integrity was calculated as the number of steps correctly executed. If the score obtained was less than 80%, the intervention was to be paused and re-training provided to the therapist until he/she could demonstrate competence in mock trials with supervisor. In the first week 50 trials were observed. Treatment integrity scores were calculated for the observation period as follows:

$$\frac{\text{Actual score}}{\text{Maximum possible score}} \times 100$$

After the first week treatment integrity checks were conducted for one trial per target per participant per month to ensure integrity of the independent variable was maintained. The treatment integrity score for intraverbal training was 88% (Range 67% – 100%).

Results

The vocal verbal repertoire of all the participants was nil during baseline condition. None of the participants acquired a single instance of speech with manual sign mand training with SSP intervention, which was ongoing for 28, 32, 42, 30 and 27 weeks for Reyan, Neha, Barry, Mahar and Ricky respectively. Once the independent variable was introduced Reyan, Neha, Barry and Mahar acquired their first instance of speech in 1, 4, 9 and 16 weeks respectively (Table 10.2). Four participants achieved n=7 instances of speech meeting the criterion for speech acquisition. Ricky did not acquire speech even after the addition of intraverbal training up to the end of the study including a follow up conducted 6 months later.

Table 10.2: Weeks to Vocal Emergence – Expt. 3

Name Code	Weeks to 1st Vocal	Week to 7th Vocals
Reyan	1	19
Neha	4	33
Barry	9	15
Mahar	16	44
Ricky	0	0

Once the Intraverbal training was introduced, Reyan emitted his first vocal /ba-ba/ under the control of antecedent verbal unit "sheep says" 2 days into the introduction of "verbal unit" paired with vocal. Thereafter on acquisition probes conducted for echoics he repeated /aa/, /pa/ and /oo/ repeating after the model. He acquired two more instances of speech as intraverbal fill-in, /cooa/ for "duck says ___" and /chuku/ for "train goes ___". The 7th instance of speech was also an intraverbal /o/ during rhyme fill-in for "Old Mac Donald had a farm, eeya-eeya" acquired in the 19th week of intervention. His vocal emergence is presented (Table 10.3) below and data graph in Figure 3.

Table 10.3: Reyan Vocal Emergence Data

Target Word	Vocal Approximations	Days to Vocal Emergence	Operant
Ba-Ba	Ba-ba	5	IV
Aa	Aa	7	Echoic
Pa	Pa	8	Echoic
Oo	Oo	10	Echoic
Quack	Cooa	11	IV
Chuk	Chuku	41	IV
O	O	99	IV

Neha acquired her first vocal in the fourth week after the introduction of intraverbal training. Her first instance of speech was /ca/, for cat, under the control of antecedent verbal unit "which one says meow?" Thereafter in the following 33 weeks she acquired /baa/, /go/, /moo/, /bow/ as intraverbals for "sheep says", "ready steady", "cow says" and "dog says" respectively. She achieved mastery criteria with /pu/ (for push on swing), and /aao/ ("come" in Hindi) during mand probes. Data on vocal emergence for Neha is presented (Table 10.4) below and graph in Figure 3.

Table 10.4: Neha Vocal Emergence Data

Target Word	Vocal Approximations	Days to Vocal Emergence	Operant
Cat	Ca	19	IV
Ba-Ba	Baa	55	IV
Go	Go	120	IV
Moo-Moo	Moo	121	IV
Push	Pu	127	EM
Bow-Bow	Bow	135	IV
Aao	Aao	166	EM

Barry acquired all his first 7 vocals as intraverbal fill-ins. He acquired two first instance of speech in the 9th week of intraverbal training. His first two vocals were /go/ for the verbal unit "ready, steady", and /o/ for the rhyme "old Mac Donald had a farm, eeya, eeya". In week 13-15, Barry vocalized /sta/ for the rhyme "twinkle-twinkle little", /boo/ for "boogie-boogie" as a television jingle, /baa/ as an animal sound "sheep says" /papa/ for the rhyme "Johnny-Johnny yes" and a contextual /thee/ for "1, 2". His days to mastery, is presented in, (Table 10.5) and data graph in Figure 3.

Table 10.5: Barry Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal Emergence	Operant
Go	Go	49	IV
O	O	49	IV
Star	Sta	69	IV
Boo	Boo	74	IV
Ba-ba	Baa	74	IV
Papa	Papa	77	IV
Three	Thee	77	IV

Mahar's first instance of speech acquisition was with /thee/ as a fill in for the antecedent verbal unit "1,2" in week 16 of intervention. He then acquired 3 instances of speech under the joint control of MO and therapists vocal model (echoic-mand) during probes in week 19, 20 and 21 respectively. These were /ee/ for chips, /m/ for music and /ba/ for biscuit. The next 3 instances of speech were intraverbal fill-in; /go/ for "ready, steady", /oo/ for "boogie boogie" and /pun/ for the rhyme "hot cross bun, hot cross". He acquired all 7 instances of speech in 44 weeks (Table 10.6) after the introduction of intraverbal fill in training. Data graphs is presented in Figure 3.

Table 10.6: Mahar Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal	Operant
Three	Thee	87	IV
Chips	Ee	105	EM
Music	Mm	110	EM
Ba-Ba	Ba	115	IV
Go	Go	131	EM
O	Oo	157	IV
Bun	Pun	228	IV

The fifth participant Ricky did not acquire any vocals (Table 10.7), Figure 3.

Table 10.7: Ricky Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal	Operant
Swing	Nil	NA	NA
Toy	Nil	NA	NA
Ball	Nl	NA	NA
Three	Nil	NA	NA
Star	Nil	NA	NA
Juice	Nil	NA	NA

Discussion

This study with a multiple baseline across 5 subjects offers evidence of effectiveness of intraverbal fill-in training, as an additional technology, in a behavior analysts tool kit to induce first instances of speech in non-vocal children with autism. Four of the five participants on this multiple baseline study acquired 28 instances of speech after the introduction of antecedent verbal unit and pairing of the target word while the mand training with SSP continued. Acquisition of speech included, 5 (18%) vocals emerge as echoic-mands under the joint control of MO and prior adult presentation of vocal- auditory-stimulus during mand training, 3 (11%) vocals emerged during echoic probes, and 20 (71%) vocals emerged as intraverbal fill-ins. Independent mands under conditions of motivating operations were not acquired by any participant.

The participants in Experiment 1 had acquired speech with only manual sign mand training with SSP. However in the current study 4 of 5 participants acquired, echoic mands and intraverbal fill in responses only after the introduction of antecedent verbal unit (VU) paired with vocal, despite being on sign mand training plus SSP intervention for periods ranging from 28 to 42 weeks onwards. Intraverbal training provided additional opportunities to emit vocals (20 trials in addition to 40 mand trials per day) and accelerated the acquisition of speech. Balsam and Bondy (1983), in their article on negative side effects of reward, propose that powerful appetitive stimuli (such as the ones used in mand training) can elicit behaviors that are incompatible with behaviors that a therapist is trying to strengthen. For instance, there were anecdotal reports in the early days of mand training with Neha that when the putative reinforcer was briefly withheld her behaviors of grabbing and trying to reach for the stimulus interfered with prompting the sign and attending to the paired vocal stimulus. With Reyan and Ricky, there were anecdotal reports to indicate that their MO for an item withheld even briefly would drop and they would scan or search for other stimuli in the environment. Given the possibility of such phenomena which have not been studied extensively in past studies, it is possible that children in this study learnt targeted vocals during intraverbal training more efficiently than during mand training. Ricky did not acquire any instance of speech; this suggests that addition of the second variable may not uniformly result in successful acquisition of speech across all participants. A comparison with other participants reveals that in the period prior to the introduction of intraverbal training while all other participants had acquired some skills in the domains of imitation, listener responding and visual performance, Ricky had acquired none, suggesting that his learning and skill acquisition barriers could account for lack of acquisition of instances of speech.

A careful analysis of the three categories of intraverbal fill-in training, such as rhymes fill-in, animal sounds and fun fill-ins during this experiment accounted for 71% of the first 28 instances of speech acquired in this study. A further analysis of vocals acquired as intraverbal fill-ins suggest, 8 (28%) vocals emerged as animal sounds, 5 (18%) were fun fill-ins, and 7 (25%) were rhyme fill-ins. The remaining 29%, were acquired as echoic mands and echoics, underscoring the supplementary role of intraverbal training in acquisition of speech by non-vocal children with autism.

While various authors (Esch et al., 2005; Miguel et al., 2002; Normand & Knoll, 2006; Smith et al., 1996; Sundberg et al., 1996; Yoon & Bennett, 2000) have studied the importance of number of pairings, for increasing post-pairing vocalizations, the intraverbal training had only one pairing/trial, compared to 2.5-15 pairings/minute in other studies. The results obtained from this experiment diverged significantly from previous studies as one pairing/trial for 20 trials/day demonstrated vocal emergence in 37 of the 46, total participants.

The study was replicated across 39 other participants on 9 multiple baselines while 2 participants continued as single subjects (Figure 3.10, Appendix 3). Of the total 46 participants selected for this experiment, 37 were male and 9 female between the ages of 1.11-12.2 years. 37 participants acquired first instances of speech while 9 remained non-vocal. The mean IOA across all MBLs was 88% (Range 74% - 97%). Total 80% participants emerged with vocals suggesting the significance of pairing a target word with antecedent verbal unit in different contexts as an additional variable to mand training with SSP. Among the 9 participants who remained non-vocal on this experiment, 2 left the study within 8 weeks of the introduction of the intraverbal training. 3 participants continued till the end without any improvements in vocalizations. The oldest participant to acquire vocal was 12.2 years old who acquired her first vocal 12 weeks after the introduction of the intraverbal training.

Introduction of the intraverbal training while mand training continued could be considered a limitation of this study as it does not isolate the independent variable however ethical considerations of withdrawing communication/mand training could have far reaching implications for the participants. Verbal discussion with guardians of a few families before beginning an experiment, for introducing the intraverbal training prior to mands did not receive acceptance hence the results of this experiment cannot be isolated from the joint effects of stimulus-stimulus pairing from both variables on vocal emergence. Addition of the second independent variable clearly had positive implications on 80% participants.

Another limitation of this study is the effect of skill acquisition on behavioral intervention along with maturation effects facilitating vocal emergence.

Future researchers could present the intraverbal fill-in training component as a variable before mand training with SSP. While ethical considerations preclude the possibility of not introducing an effective intervention such as mand training for non-vocal children with autism, introducing the intraverbal training for a brief period initially may identify its effect on vocal emergence. Another challenge that could be addressed in future studies is the measurement of factors such as ‘excitement building’ and ‘suspense’ during fun fill-in training, and rhyme fill-in training. It would also be important in such experiments to observe the participant and measure ‘excitement’ and ‘joy’ related behaviors such as laughter and wide-eyes, and relate them to emission of vocals under stimulus control.

Figure: 3.0 Experiment 3

Effect of introducing intraverbal training with mand training and SSP in Phase 2

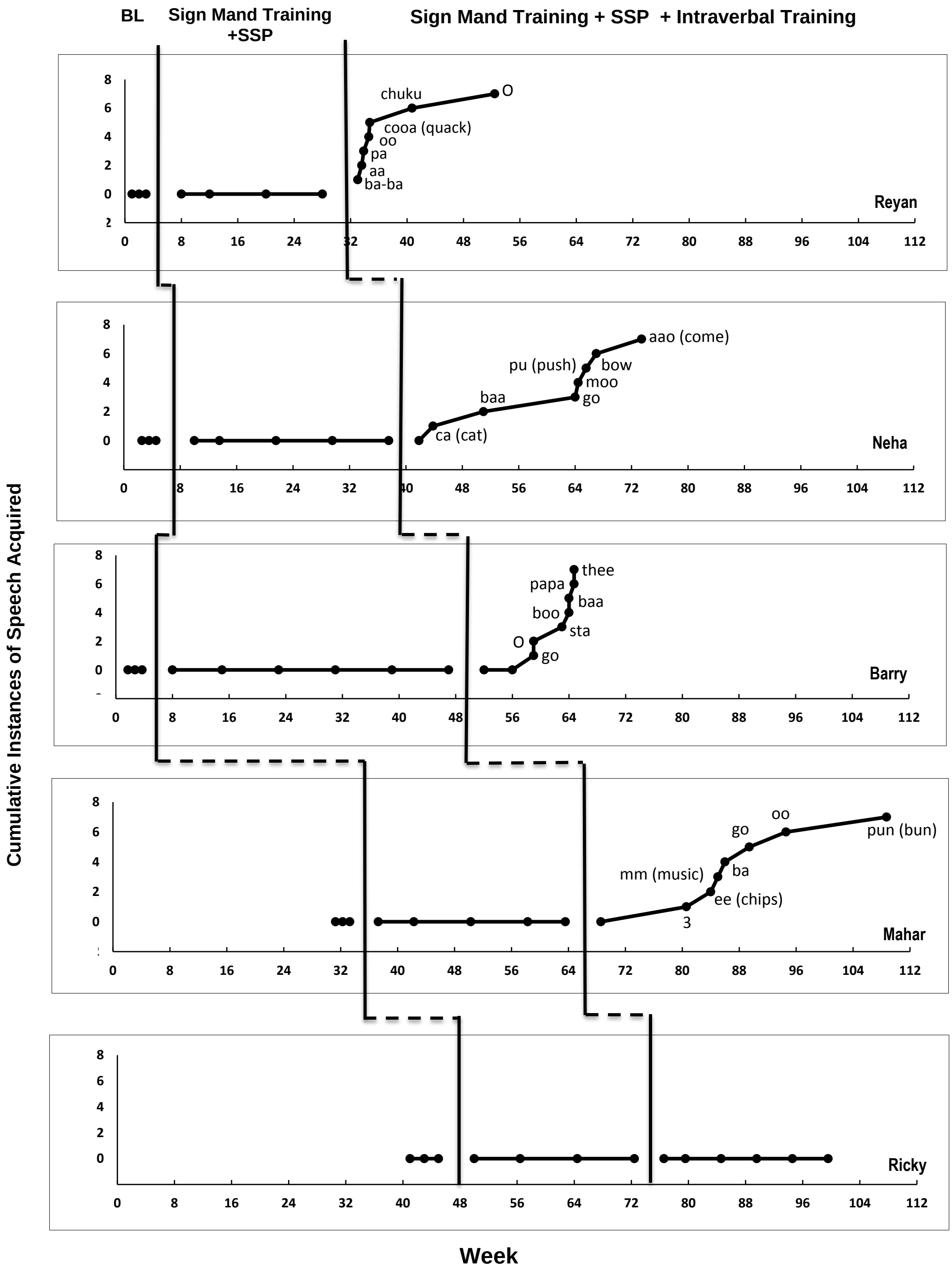


Figure 3.0: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with

Replications Experiment 3

Replications of Experiment 3 were conducted for participants who did not acquire any vocalization during mand training with SSP, resulting in the addition of a second independent variable, i.e. an “antecedent verbal unit” paired with vocal (intraverbal training). A total 39 participants, displayed on an additional 9 delayed multiple baselines (MBL), i.e. total number of participants in Experiment 3, n=46. While data for the first 5 participants (MBL 3.0) have been described in detail above, other participants were added to the experiment as a previous participant acquired a minimum of one vocal after the introduction of intraverbal training (second independent variable). At times when a participant did not acquire vocals for a minimum 3 months, a participant was added on the MBL while the previous continued on the intervention. Tables below (MBL 3.1 – 3.9) provide details of participants on each delayed-MBL, with regards to age, gender, and number of days to first vocalization as well as number of days until they met criteria (n=7 vocalizations). Full data sets including vocalization graphs are available in Appendix 3.

Each delayed-MBL had between 3-8 participants. Two participants continued as single-subjects with no further participants available. Of the total n=46 participants in this experiment, 37 acquired vocalization, meeting the mastery criteria while 9 remained non-vocal. Mean IOA on vocal emergence across all MBL’s was 88% (Range 74% to 97%) confirming the emergence of vocalization.

Results from 46 participants showed that, 37 (80%) participants emerged with vocals after the introduction of verbal unit paired with vocals (intraverbal training) while mand training with SSP continued, presenting evidence the addition of intraverbal training has on vocal emergence. These data are presented in 9 multiple baseline graphs (Figures 3.1-3,9) in Appendix 3. Two participants participated as single subjects and their data is presented (Figure 3.10, Appendix 3).

Summaries of participants in Experiment 3 replication studies MBL 3.1-MBL 3.9: Age, gender, onset of vocalizations and time to meeting criterion.

MBL 3.0

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	Reyan	1.10	M	3	99
2	Neha	3.5	F	19	166
3	Barry	3.2	M	49	122
4	Mahar	3.4	M	81	222
5	Ricky	2.11	M	0	0

MBL 3.1

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	AKA	4.11	M	14	141
2	SYE	3.11	M	5	60
3	MTH	6.11	F	65	120

MBL 3.2

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	MDU	3.4	F	32	122
2	ASH	4.8	M	49	237
3	RPR	2.2	F	119	220
4	AJAV	2.8	M	0	0
5	SSR	3.4	M	18	116
6	YDH	4.2	M	107	568

MBL 3.3

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	JSR	3.5	M	24	24
2	AMAD	3.4	M	0	0
3	SAV	2.6	M	16	33

MBL 3.4

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	Ann	12.2	F	96	115
2	RHA	4.6	M	254	258
3	SSA	4.9	M	108	315
4	ASUR	5.2	M	0	0
5	AJSI	4.3	M	176	239
6	CMA	4.8	F	173	250
7	SVEN	4.9	M	111	139
8	MCH	1.8	F	0	0

MBL 3.5

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	KBA	6.0	F	52	176
2	APA	5.11	M	203	461
3	AKUM	2.7	F	113	113
4	NYGA	2.0	M	0	0

MBL 3.6

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	ASHE	4.9	M	11	405
2	SMAT	6.0	M	5	327
3	RCH	5.5	M	76	76

MBL 3.7

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	DRO	2.9	M	172	229
2	VPR	4.0	M	157	159
3	SPA	4.7	M	37	51

MBL 3.8

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	KGR	4.11	M	100	516
2	AJA	4.2	M	11	180
3	AJO	6.10	M	0	0
4	AV	2.3	M	387	448
5	VKH	4.8	M	4	50

MBL 3.9

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	AMAL	4.5	M	174	622
2	NGA	2.8	M	365	462
3	ARA	3.2	M	45	219
4	ISK	2.11	F	32	344

Single Subject

Participants	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	AMEH	3.9	M	0	0
2	AKE	3.0	M	0	0

Each participant on the following four MBLs (MBL 3.1, MBL 3.6, MBL, 3.7 and MBL 3.9) acquired vocal mastery criteria; one participant each on 4 MBLs (MBL 3.2, MBL 3.3, MBL 3.5, MBL 3.8), and 2 participants on (MBL 3.4), did not vocalize. Both single subject participants also remained non-vocal.

Early vocal emergence

The following 7 participants, namely, AKA and SYE (MBL 3.1), SSR (MBL3.2), SAV (MBL 3.3), AJA and VKH (MBL 3.8), acquired first instances of speech within 2 weeks of introducing intraverbal training, after being non-vocal for 10-18 weeks, while on mand training with SSP. Participant SYE was 3.11 years old, and was on mand training with SSP for 17 weeks. He emerged with the first vocal in 3 days, after the introduction of intraverbal training; achieving 2 echoic mands and 5 intraverbal fill-ins; and met mastery criteria n=7 vocals within 60 days, taking less than 10 days to achieve each vocal. His first vocal was an echoic-mand; while the next five vocals were intraverbal fill-ins with the final vocal emerging as an echoic mand. His first vocal /aam/ was under multiple control of the motivating operation as well as the paired vocal as he manded for preferred fruit. He then acquired a rhyme fill-in /aa/ for star, when the therapist sang “twinkle twinkle little”; the next vocal was a fill-in for animal sound /ba/ for “sheep says”, followed by another rhyme fill-in, /o/ for “Old Mac Donald had a farm eeya eeya”, the fifth vocal was a fun fill-in /three/ for “1,2” as the therapist said just before running, the 6^{th} vocal was another rhyme fill-in /hah/ when the therapist sang “johnny johnny yes papa”, and the seventh vocal was part mand part echoic /pop/ when the therapist blew bubbles.

JSR, a 3.5 years old boy was on mand training with SSP for 12 weeks. After the introduction of intraverbal training, he acquired his first vocal /aa/ for star, as a rhyme fill-in for “twinkle, twinkle”. On acquisition probes he echoed after the therapist vocalizing 6 different sounds /ee/, /aa/, /oo/, /ba/, /do/ and /hi/ to meet mastery criteria; acquiring all 7 vocals on the 24th day of intervention. A third participant SAV was 2.6 years old, previously on mand training and SSP for 14 weeks. On the introduction of intraverbal training, he vocalized for the first time in 16 days and achieved mastery criteria within 33 days, taking an average 5 days for each vocal. All his vocals emerged as independent mands under the control of the motivating operations. The vocals acquired were /ss/ for spin, /ou/ for out, /che/ change, /wu/ water, /bau/ for ball, /to/ for toy, and /cho/ for chocolate.

Another participant, VKH achieved vocalization between 4-50 days, with the first vocal an intraverbal fill-in and a total of 5 intraverbals, 1 echoic-mand and 1 echoic. Participant AJA at the age of 4.2 years was on mand training for 16 weeks and emerged with his first vocal on day 11, after the introduction of intraverbal training. He acquired 4 intraverbal fill-ins as animal sounds i.e. /ba-ba/, /moo/, /neigh/, and /tooee-too/ for “sheep says”, “cow says”, “horse says” and “bird says”; 2 fun fill-in, such as /go/ for “ready, steady” and /wee/ for “aeroplane goes”. Similar results were obtained when participants AKA and SSR achieved vocal mastery criteria within 51, 141 and 116 days respectively after being on mand training with SSP for 14-17 weeks with the first vocal emerging within 18 days.

These replications suggest immediate vocal emergence in some children with the addition of intraverbal training. Vocal emergence varied across “verbal operants”, such as some children vocalized under contingencies of the motivating operations, others had vocals emerging as intraverbal fill-ins while some had echoic-mands.

Vocals as Intraverbals

Only 4 participants, MDU (MBL 3.2), CMA (MBL 3.4), KBA (MBL 3.5) and SPA (MBL 3.7), acquired all 7 vocals as intraverbal fills. MDU, a 3.4 year-old female, acquired 4 animal sounds, 2 fun-fills and 1 rhyme fill-in taking 32-122 days for achieving mastery criteria. While she continued on mand training with SSP, the pairing effects of vocal emergence as intraverbal fill-ins presents an interesting scenario. CMA and KBA took 250 and 176 days respectively to emerge with vocals, and despite the continuation of mand training acquired all vocals as intraverbal fill-ins. SPA was a 4.7 year-old boy who was previously receiving special education and had an older sibling on the autism spectrum; he was on mand training with SSP for 10 weeks. SPA acquired his first vocal /baa/ as an intraverbal fill-in taking 37 days for his first vocal. He acquired the remaining vocals as fill-ins for animal sounds (2), and rhyme fill-in (4) in 51 days.

Long duration of mand training

Some participants were on mand training and SSP for a long duration between 24-80 weeks, represented in Figures 3.1-3.10 (Appendix 3); namely, MTH (MBL 3.1), MDU and ASH (MBL 3.2), ASUR, and CMA (MBL 3.4), ASHE and SMAT (MBL 3.6), and DRO (MBL 3.7).

MTH was a 6.11 years-old girl (MBL 3.1) and was on mand training with SSP for 32 weeks before the intarverbal training was introduced. She had a baseline assessment score of 12 (BLA) and severe behavioral rigidities. For example when she transitioned from the table top to the play park area she followed certain routes and rituals and would get extremely upset, crying many times if not allowed to complete those rituals. After the implementation of intraverbal training, she acquired her first vocal in 65 days and achieved the rest 6 vocals in another 60 days to reach mastery criteria. Her first vocal /ba/ for biscuit, was an echoic mand and she acquired vocalizations as 4 echoic mands, 1 intraverbal rhyme fill in and 2 echoics. It is not evident if MTH’s vocal acquisition was delayed due to ritualistic behaviors, which interfered with pairing effects, or the selected targets, which competed with her ritualism and were not valuable enough; or the timing of implementation of intraverbal training, which corresponded with reduction in behaviors. The vocals emerged suggest pairing effects under motivating operation.

Another participant, a 3.4 years old girl at intake, namely MDU (MBL 3.2), was on mand training with SSP for 50 weeks. She was a quiet and gentle girl with a baseline assessment score of 12 (BLA). Once intraverbal training was introduced, she acquired her first vocal /moo/ for “cow says” in 32 days. She reached mastery criteria within 122 days, taking an average 20 days to acquire each vocal.

Participant ASH (MBL 3.2) was a 4.8 years old cooperative and quiet boy, with a baseline assessment score of 12 (BLA). Intraverbal training was introduced as he had been on mand training with SSP for 56 weeks. ASH acquired his first vocal /aa/ for all kinds of toys, in 49 days as an echoic mand. Subsequently he acquired his next 6 vocals within 10 weeks; vocalizing /pi/ for puzzle as an echoic-mand, and emerged with echoic /ee/ on acquisition probes, the next two vocals /see/ for swing, and /bu/ for bubbles were echoic mands and /pu/ emerged as an echoic. After this there was a long interval of 26 weeks. He acquired the final vocal /o/ as an intraverbal fill for the rhyme “Old mac Donald” to achieve mastery criteria. The remaining participants, namely, CMA (MBL 3.4), ASHE and SMAT (MBL 3.6), and DRO (MBL 3.7); took 250, 405, 327 and 229 days to reach criterion.

Vocal acquisition interval

Some participants responded to the intervention after a long interval, however once the first vocal emerged the remaining 7 vocals were acquired within a short period of time. Four participants, RPR (MBL 3.2), Ann (MBL 3.4), AKUM (MBL 3.5), and VPR (MBL 3.7) took 96-220 days to acquire vocals n=7, to achieve mastery criteria. Each participant had undergone 22, 14, 16, and 16 weeks respectively of mand with SSP training, before the introduction of intraverbal training. AKUM (MBL 3.5) was 2.7 years old and the younger sibling of a high functioning child with autism. She exhibited cooperation issues, and could not wait for reinforcers; would often close her eyes partially when the mand protocol was implemented, snapping them wide open during delivery. She acquired her first two vocals /wa/ for water and /toy/ as echoic mands followed by 5 intraverbal fill-ins on acquisition probes taking between 119-220 days to meet criteria. Another participant namely, VPR (MBL 3.7) was a 4 year-old boy with a baseline assessment score of 12 (BLA) who took 157 days to vocalize /jum/ for jump, pop, car, toy, out, /bo/ for ball and push. He acquired all his vocals as echoic-mands and reached mastery criteria within 2 days. Participants Ann (MBL 3.4) similarly took 96-115 days to reach mastery criteria for vocalization. While the first instance of speech took long, the acquisition of vocals happened in a short interval for these four participants.

Many participants, nearly 20 of 41 had very delayed vocal emergence taking an average 325 days to vocalize the first 7 vocals. Of these, 6 participants namely SSA, CMA, AKUM, VPR, AV and ARA, emerged with clear vocals, while all remaining 13 participants emerged with phonemes during vocalization. Emergence of speech across verbal operants included intraverbals and mands, however many participants also acquired echoic-mands, suggesting the importance of motivating operations and paired vocals emitted by the therapist, for severely speech delayed children.

Finally, there were 8 of 41 participants on the replications namely, AJAV (MBL 3.2), AMAD (MBL 3.3), ASUR and MCH (MBL 3.4), NYGA (MBL 3.5), AJO (MBL 3.8), AMEH and AKE (SS 3.10) who remained non-vocal. It needs mention that for participant MCH, a 1.8 year- old girl; there is documented evidence of a variety of words she has emerged with, during intervention however she is yet to meet the mastery criteria due to lack of consistency. Another participant NYGA a 2 years old child was reported to have been placed on medication midway during the intervention to reduce anxiety.

Summary

Experiment 3 and its replications demonstrate varying degrees of effect on different children, and the additive effect of intraverbal training for participants who did not vocalize for long periods. A total 37 of 46 (80%) particpants acquired vocal mastery criteria after the addition of intraverbal training. Of these, 9 participants acquired n=7 mastery criteria rapidly. The remaining participants had long intervals either between the first and seventh vocal, or between the introduction of the intraverbal training and the first instance of speech. This raises many questions: did the presence of co-occuring conditions in children with autism affect vocal acquisition which might be the reasons for stimulus-stimulus pairing under motivating operations, and verbal unit presentations not being effective with participants below the age of 3 years? Were maturation effects responsible for vocal emergence or did intraverbal training have any effect at all in vocal acquisition?

Early emergence of vocals on introduction of intraverbal training in 9 participants provides strong evidence of effectiveness and the emergence of vocals as intraverbal operants at a later stage adds to the evidence. Both need to be studied further.

EXPERIMENT 4

Title: The effect of a treatment package including sign mand training with SSP and intraverbal training with paired stimulus on non-vocal children with autism.

Background to Current Study

In Experiment 1.0, five non-vocal children with autism participated in a delayed multiple baseline study. Each underwent sign mand training with stimulus-stimulus pairing of an auditory target word under conditions of motivating operation. Participants 1,2 4 and 5 on the multiple baseline started acquiring first instances of speech within 2-8 weeks of intervention adding to the body of evidence that sign mand training with paired auditory stimulus can be effective in inducing first instances of speech in children with autism. The third participant did not acquire any speech until 60^{th} week despite exposure to the same intervention. This result suggests that, there might be other variables that could influence the outcome of speech acquisition in children with autism. Some of these variables may not be readily available for examination by a researcher such as participant's history of failed treatments, auditory discrimination skill, discrimination between sound heard and sound produced if any or flexibility and manipulability of vocal musculature related to speech production. Experiment 1 was further replicated in 13 additional delayed multiple baseline studies with 58 participants between ages 1.4 years and 9.6 years of whom 48 participants went on to acquire 7 instances of speech as mands, or echoic-mands (Figures 1.2-1.13, Appendix 3).

In Experiment 3.0, five participants began with sign-mand training with SSP however despite being on the intervention for 27-42 weeks none acquired first instances of speech. Therefore, intraverbal training, where an antecedent verbal unit was paired with a target fill-in word, was introduced as an additional variable in the second phase of the experiment in addition to the sign-mand training. During this experiment, two of the five participants acquired first instances of speech within a week of addition of intraverbal training component. Two additional participants started acquiring first instances of speech at 9 and 16 weeks from the introduction of intraverbal training. However, one participant did not acquire any speech even after 28 weeks of mand training and a further 28 weeks of sign mand and intraverbal training. The acquisition of instances of speech after the introduction of intraverbal training with 4 out of 5 participants adds to the evidence that intraverbal training could have an additive effect in vocalization. Experiment 3 was further replicated with 39 participants across 9 additional multiple baselines across participants, and 2 participants on single subject design. A total 37 of 46 participants on experiment 3, went on to acquire first instances of speech as per mastery criterion after the addition of intraverbal training component while 9 participants remained non-vocal. Addition of an intraverbal component as discussed previously provides evidence of an accelerative or additive effect for many participants in acquisition of vocals. This leads to the question whether non-vocal children with autism could have acquired vocalization in due course and the timing of introduction of intraverbal training may have been adventitious and prepared the participants for speech acquisition.

Current Experiment

Introduction

The current study applied manual sign-mand training with SSP and intraverbal training with paired vocals together at the introduction of intervention, to determine the effect of such a treatment package on acquisition of first instances of speech in non-vocal children with autism. Nineteen participants, 17 males and 2 females, between ages 2.9–9.2 years, participated in this study. Each participant was introduced on one of the five delayed multiple baseline studies as the previous participant acquired at least one instance of speech. Two multiple baseline studies are discussed in detail below. The remaining 3 delayed MBL graphs presented in Appendix 3 (Figures 4.1, 4.4 & 4.5) serve as replications and their finding are presented in discussions.

Method

Participants and Settings

Five boys and one girl, Narvey, Huber, Rita, (MBL 4.2), Hans, Lika and Junaid (MBL 4.3), aged between 3 years and 5.6 years who met the diagnostic criteria participated in this study. Two multiple baseline studies (MBL 4.2, MBL 4.3), with the second as a replication are discussed here. Participants Narvey, Huber & Rita assigned to delayed-MBL (4.2) participated as the previous participant acquired a minimum one vocal on a pre-decided criterion.

Narvey was 5.6 years old at intake, and received diagnosis from a developmental pediatrician. On the BLA, Narvey scored between Level 1 and 2 in most domains. He was unable to communicate using sign mands and did not demonstrate imitation skills. He received a total score of 18 out of a maximum possible of 60 (Appendix 4) and his EESA score was nil.

Huber was a 5.2 years old boy diagnosed as mild autistic by a psychiatrist. While he was non-vocal at intake, he complied with instructions, performed on visual performance tasks, such as, matching identical objects, matching non-identical pictures of same items, and matching items that go together. He could imitate most gross and fine motor movements modeled by adults however did not imitate oral motor instruction. His listener responding, requesting, labeling and other skills were limited. His BLA score was 26 of 60 (Appendix 4) and EESA score was nil.

Rita was a 4.1 years old girl diagnosed as being under autism spectrum disorder when she was 3.6 years old in the United States. During the initial interview, her mother reported that Rita was a premature baby and there was some delay in her motor milestones. She also reported that Rita was using single words to communicate when she was one and half years old however there was regression in her speech. Rita started with an intervention for two months in a special school before the family shifted to India. During intake assessments while Rita engaged with stacking activities and would listen to music, several pre-requisites such as making eye contact, scanning stimuli in front, waiting without touching preferred stimuli were absent. She identified certain everyday objects from an array, and identified numbers 1-10; however, she had no communication skills and did not echo when asked. When presented with a model she imitated a few gross motor movements and tasks with objects. Her BLA score was 19 of a maximum 60 (Appendix 4) and her EESA score was nil.

Hans, Lika and Junaid participated in the replication and were assigned to a second multiple baseline study (MBL, 4.3). Hans was the first participant of the replication.

Lika was shortlisted after 4 weeks of Hans being on intervention and was introduced on the delayed multiple baseline after Hans achieved minimum one vocal. Twelve weeks of Lika being on the intervention, Junaid joined as a participant meeting criterion. He remained on baseline for 8 weeks till Lika acquired more than one vocal.

Hans was a 2.11 year old boy diagnosed with autism spectrum disorder, provided by a neurodevelopmental pediatrician in Mumbai and was brought for intervention soon after by his parents. At the time of intake, Hans had no imitation skills, he did not respond to receptive instructions, did not make eye contact, had no communication skills and was not cooperative. His score was a minimum at Level 1 across all domains of BLA assessment taking his BLA score to 12 out of 60 (Appendix 4). His EESA score was nil.

Lika was a 2.11 years old boy who had a diagnosis of ASD. Lika had a history of seizures and was on medication when he joined the intervention. Lika was non-cooperative in the initial days and preferred to sit in a corner and cry. He would not allow physical prompts or touch and his therapists would engage in parallel play to effect pairing. He scored only the minimum possible score on all domains of the BLA taking his score to 12 (Appendix 4). He score was nil on EESA.

Junaid was a 5.6 years old boy with strengths in gross motor and fine motor imitation. He did not have appropriate play and would engage in problem behaviors such as pinching, running, crying, throwing objects, and weaving his fingers in the air. He did not demonstrate any receptive language skills, visual performance, communication, or vocal play. His BLA score was 17 out of maximum possible 60 (Appendix 4) and his EESA score was nil.

Mand training with SSP was conducted at the table, play area and the computer area under conditions of motivating operation as the participants were rotated across environments; similar to previous experiments. Intraverbal training, i.e. pairing the antecedent verbal unit with target word, was conducted for animal sounds and rhyme fill-in at the tabletop while both experimenter and participant sat on chairs across a table whereas fun fill-ins were conducted in the natural environment.

Response definition, Measurement and Inter observer agreement:

The dependent variable as in previous experiments was the acquisition of an instance of speech as a syllable, phoneme, word or word approximation as a mand, echoic-mand, tact, echoic or intraverbal. A participant was deemed vocal on the acquisition of n=7 vocalizations.

Response measurement as per previous experiments was made during baseline on 3 successive days (Form 7, Appendix 1) to assess if participants could emit vocals under stimulus control. Baseline probes conducted by a supervisor and a therapist showed 100% IOA on the non-vocal status of each participant. During intervention, the therapist collected "yes/no" data on first probes of the day (Form 15, Appendix 1) for each of the 9 selected target (6 mands and 3 intraverbal fill-ins). Once the participant emitted vocals consistently for 5 consecutive days on a target the supervisor confirmed acquisition both conducted acquisition probes (Form 12, Appendix 1) on mands, tacts, echoics and intraverbal fill-ins. This was repeated for each vocal acquired i.e. n=7; as per previous experiments. For each participant who acquired each instance of speech, the IOA was calculated as, the total number of agreements divided by total probes and multiplied by 100. The IOA for Narvey, Huber, and Rita (MBL 4.2) was 91%, 86%, and 89% respectively (Range 86% to 91%), and for participants Hans, Lika, and Junaid (MBL 4.3) was 83%, 89%, and 86% respectively (Range 83% to 89%).

Stimulus Preference Assessments

Preference assessments were conducted, as detailed in the previous experiments to select targets before the implementation of mand training with SSP If tangibles and edibles could not be identified; situations were contrived to evoke action mand, and those were selected as targets. The preference assessment also identified high value preferred items, for pairing, during intraverbal training. None of the stimuli selected for mand training, were used as reinforcers for intraverbal training trials and utmost care was taken to avoid this. The preferred list of items for each participant is presented in Table 11 below.

Table 11: List of Preferred Items

Participant	Preferred Items
Narvey	Car, Toy, Bubbles, Pencil, Chocolate, Music, Swing, Ball, Water, Merry-go-round
Huber	Swing, Chips, Toy, Book, Puzzle, Crayon, Bubbles, Chocolate,
Rita	Bubbles, Book, Puzzle, Toy, Music, Chips, Rhymes on computer, Swing, Trampoline
Hans	Biscuit, Car, Chips, Water, Book, Ball, Phone, Music on computer, Swing, Slide, Trampoline
Lika	Bubbles, Toy, Crayons, Book, Puzzles, Chips, Ball, Swing, Slide
Junaid	Ball, Apple, Toy, Music, Swing, Trampoline Contrived: Come, Open, Push

Target Selection for Mand and Intraverbal Training

Six mand targets were selected from the preference assessment list (Table 11), as described in Chapter 9 from toys, edibles, play equipment and rhymes on the computer, or situations were contrived with action mands. Three intraverbal targets were selected from each of the three categories: i.e. animal sound fill-in, fun fill-in and rhyme fill-in.

Additionally, it was ensured, that the sounds of target words in mands and the intraverbal fill-in sounds were clearly discriminable. An example of clearly discriminable sounds would be ‘star’ in intraverbal fill-in and ‘chips’ in mand targets. A non-example would be having “ moo” as a target for “cow says”, and “music” as a target in mand.

Experimental Design:

A delayed multiple baseline across subjects was used with each of 3 participants. The baseline lengths were varied, where the baseline data were not concurrent for better experimental control. The next participant was added after the previous participant acquired a minimum one vocal. Cooper, Heron & Heward (2007) state that,
“ Behavior Analysts using any type of multiple baseline design must be sure that all baselines, regardless of when they were begun, are of sufficient and varied length to provide a believable basis for comparing experimental effects” (p. 234).

Procedures

Baseline

Mand, intraverbal, tact and echoic probes were conducted (Form 7, Appendix 1) as described in Experiment 1, across 3-5 days for each participant, before the intervention to ascertain non-vocal-verbal status of each participant.

Sign Mand Training with SSP and Intraverbal Training

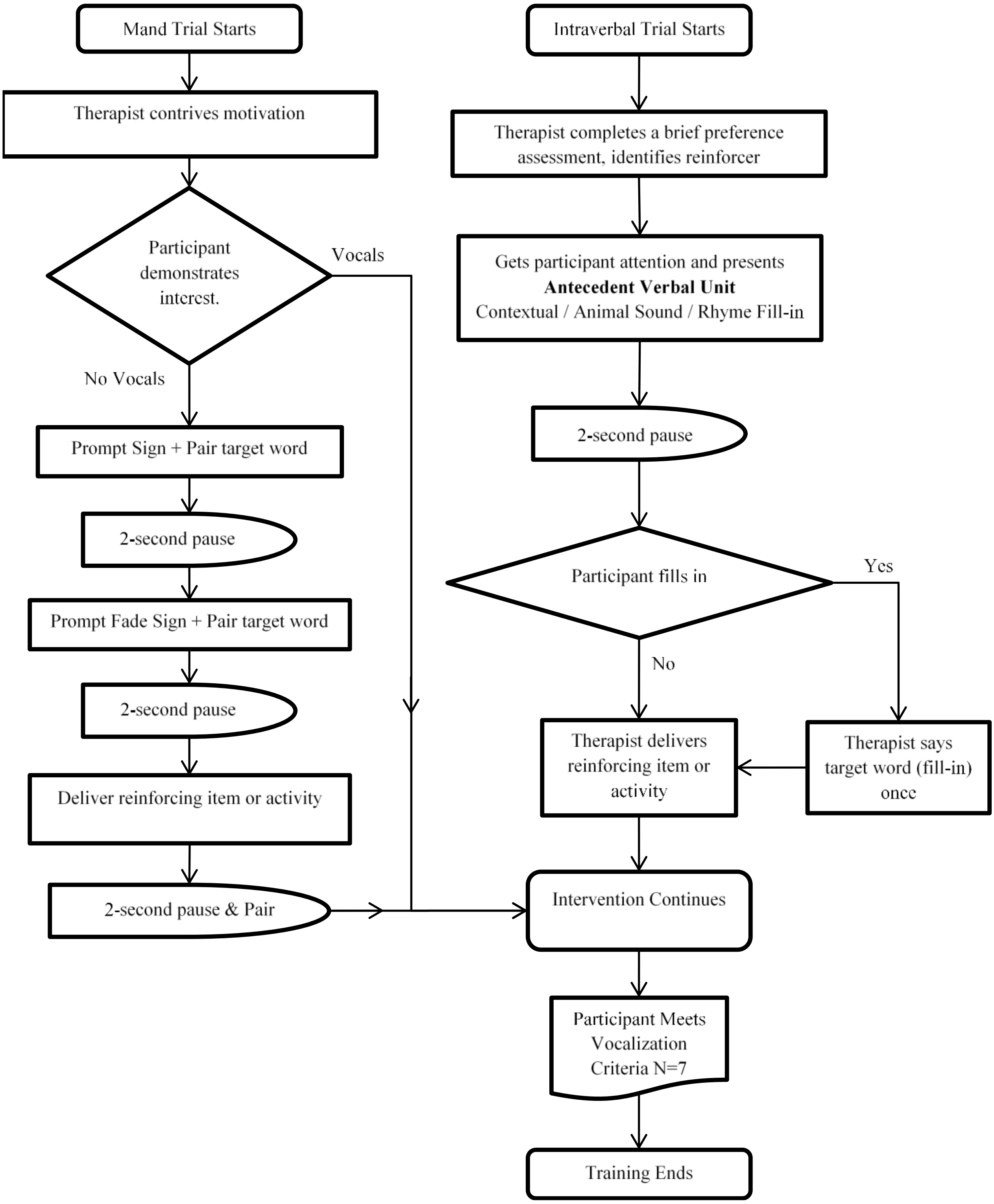
The procedures (Flow Diagram 4) used were identical to those used in sign mand training with SSP as in Experiment 1, and the procedures used for intraverbal training were identical to the procedures used in Experiment 3. Both independent variables were introduced together during this experiment; which included 40 trials of sign-mand training with SSP and 20 trials of intraverbal training with paired word in each session of 2 hours. The trials were interspersed within the IBI session and conducted by the same therapist.

Integrity of the Independent Variable

A supervisor assessed integrity of both the independent variables during training. The therapists were observed on specific training components for mand training as well as intraverbal training as described in Experiments 1 & 3. 50% trials were observed for each independent variable in the first week of intervention. If the score was less than 80% retraining was provided. Once intervention began, observations were made for each selected mand trial (i.e. a total 6), and intraverbal trial (i.e. a total of 3); once a month till the intervention was completed.

The treatment integrity score (Table 18, Appendix 2) for mand training was 83% (Range 80% - 87%) and 84% (Range 80% – 100%) for MBLs 4.2 and 4.3 respectively. Treatment integrity scores for intraverbal training were 92% (Range 73% - 100%) and 87% (Range 67% to 93%) on MBLs 4.2 and 4.3 respectively.

Flow Diagram 5: Simultaneous Introduction of Mand and Intraverbal Training



Results

In this study, as with the previous experiments, none of the children had any instance of speech in baseline conditions. After the introduction of the treatment package, that is verbal unit paired with vocal (intraverbal training) and sign-mand training with SSP; all 6 participants from delayed-MBL 4.2, and its replication (MBL 4.3), acquired n=7 instances of speech. Huber and Rita started acquiring first instances of speech in a weeks time into the intervention. Junaid emerged with vocals within 2 weeks, while Narvey and Hans acquired first instances of speech 6-10 weeks from the day the intervention was begun. Lika took the longest, 16 weeks, to acquire first instances of speech.

Table 11.1: Weeks to Vocal Emergence – Expt. 4.2 & 4.3

Name Code	Weeks to 1st Vocal	Week to 7th Vocals
Narvey	6	12
Huber	1	4
Rita	1	4

Name Code	Weeks to 1st Vocal	Week to 7th Vocals
Hans	10	16
Lika	16	30
Junaid	2	19

Narvey's speech emerged as intraverbal for all the first seven instances of speech. His first four specific vocals were /bow-bow/ for "dog says___", /ha-ha/ as fill in for "Johnny-Johnny yes papa" rhyme, /meow/ for "cat says", and /go/ when presented with "ready, steady". He acquired additional 3 instances of speech namely, /cluck/ for "hen says", /eat/ when the verbal unit was "Narvey is going to?" and /mu-mu/ for "cow says" in the following 6-12 weeks from the introduction of the treatment package (Table 11.2).

Table 11.2: Narvey Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal	Operant
Bow-bow	Bow bow	35	IV
Ha ha ha	Ha Ha	41	IV
Meow	Meow	43	IV
Go	Go	46	IV
Cluck-Cluck	Cluck	59	IV
Eat	Eat	64	IV
Moo-Moo	Mu-mu	73	IV

Huber was added as the next participant on the delayed MBL soon after Narvey had acquired 5 instances of speech. Huber acquired his first 7 instances of speech as 6 intraverbal fill-ins and 1 mand. His first 7 specific vocals were; /go/ as a fill-in for "ready, steady", /yes papa/ for "Johnny-Johnny", /push/ as a mand while seated on the swing, /home/ as a contextual fill in for "you are now going", /hurry/ as a fun-fill-in for "hip-hip (hurray)!" /duck/ for, "what says quack-quack?" and /moo/ for "cow says". He acquired all vocals within 4 weeks (Table 11.3) and used words with clarity.

Table 11.3: Huber Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal	Operant
Go	Go	7	IV
Yes papa	Yes Papa	7	IV
Push	Push	10	M
Home	Home	15	IV
Hurray	Hurry	19	IV
Duck	Duck	19	IV
Moo	Moo	19	IV

Rita joined the study as a non-vocal child with autism two weeks after Huber had achieved all 7 vocals as a delayed participant. Her intervention started 3 weeks after Huber's speech evocation. Rita acquired her first vocal /toy/ as a generalized response for the various toys within 10 days. Thereafter she acquired two vocals within a fortnight, /bubble/ as a mand, and /go/ as an intraverbal fill-in for "ready steady". Before the fourth week of intervention Rita acquired /music/ as a mand, /move/ for removing an obstruction while watching video on computer and /jump/ mand on the trampoline. Her 7th instance of speech was filling-in /three/ during the fun fill-in “1,2”. Rita’s rate of vocal acquisition was rapid, with words acquired under conditions of motivating operation as well as antecedent verbal unit paired with vocals. She did not acquire any signs. All vocals emerged within 4 weeks (Table 11.4).

Table 11.4: Rita Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal	Operant
Toy	Toy	7	M
Bubble	Bubble	14	M
Go	Go	16	IV
Music	Music	18	M
Move	Move	18	M
Jump	Jump	19	M
Three	Three	21	IV

Three participants Hans, Lika and Junaid from the replication study (MBL 4.3) had similar results. Hans as the first participant on the replication, acquired his first instance of speech /ba-ba/ for “sheep says” within 10 weeks of intervention. Next, he acquired /chip/ for chips as an independent mand and on the acquisition probe vocalized /bishit/ for biscuit. Hans’ fourth vocal was /go/ for “ready steady” as an intraverbal. During acquisition mand probes 3 remaining instances of speech emerged as mands; /watu/ for “water”, /swi/ for “swing” and /caa/ for “come”. By week 16, he reached mastery criteria (n=7 vocalizations), presented in Table 11.5 and data graph in Figure 4.3. When Hans had acquired his first 3 instances of vocalizations, Lika started on the intervention.

Table 11.5: Hans Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal	Operant
Ba-Ba	Ba-Ba	46	IV
Chip	Chip	62	M
Biscuit	Bishit	63	M
Water	Watu	73	M
Go	Go	73	IV
Swing	Swi	75	M
Come	Caa	76	M

Lika was on non-contingent pairing for 5 weeks, prior to intervention. He had settled, was allowing the therapist to touch him and hold his hand, and was no longer confined to the corner. Once the independent variable was implemented, Lika acquired an echoic-mand, 4 echoics and 2 intraverbals. He acquired his first vocal after 16 weeks while repeating /bu/ after the therapist during stimulus-stimulus pairing of target word “bubble” under motivating operation conditions. During acquisition probes he imitated the model sound and emerged with 4 vocals /aa/, /ee/, /oo/, /mu/ as echoics; taking another 14 weeks to reach mastery criteria (n=7 vocalizations) with intraverbal fill-ins, /ba-ba/ for “sheep say” and /go/ for “ready, steady”. Days to vocal emergence presented in Table 11.6 and data graph in Figure 4.3.

Table 11.6: Lika Vocal Emergence Data

Target Word	Vocal Approximation	Days to Vocal	Operant
Bubble	Bu	83	EM
Aa	Aa	83	Echoic
Eee	Eee	83	Echoic
Oo	Oo	83	Echoic
Mu	Mu	83	Echoic
Ba-Ba	Ba-Ba	151	IV
Go	Go	151	IV

*EM=Echoic-mand *IV=Intraverbal

Junaid’s intervention started when Lika had acquired 5 instances of speech. He acquired 2 vocals as intraverbal fill-ins, within 2 weeks of intervention, these were /go/ as an intraverbal in response to “ready, steady”, and /ba-ba/, in response to “sheep says”. He took another 15 weeks to independently vocalize /ball/ when he wanted ball.

Table 11.7: Junaid Vocal Emergence Data

Target Word	Vocals Approximation	Days to Vocal	Operant
Go	Go	8	IV
Ba-Ba	Ba-Ba	17	IV
Ball	Ball	94	M
Water	Water	94	M
Apple	Apple	94	M
Open	Open	94	M
Come	Come	94	M

During acquisition probes conducted on the same day, Junaid vocalized /water/, /apple/, /open/ and /come/ as echoic-mands under conditions of motivating operations. His speech was clear and he did not acquire any signs. Data on Junaid's days to vocal are presented in Table (11.7), and data graph in Figure 4.3.

Discussion

This study provides strong evidence and experimental control for emergence of vocalization, across 6 non-vocal participants with autism when a treatment package consisting of mand training and SSP was implemented together with antecedent verbal unit paired with vocal. A recommendation that emerges from this study would be that intraverbal fill-in training with an antecedent verbal unit paired with vocal be added as early as possible to sign mand training with SSP to induce first instances of speech. In both multiple baseline studies all children went on to acquire the required first 7 instances of speech after the introduction of intervention. In the first MBL even though a non-concurrent MBL design was used, Rita joined one week after the previous participant Huber had acquired 7 instances of speech as a delayed participant. The introduction to the intervention after speech acquisition of previous participant on the treatment package shows a strong experimental control in this study.

With the 6 participants elucidated above speech acquisition occurred as mands, echoics, intraverbals and echoic-mands. Of the 42 vocals across the six participants, 21 were intraverbal fill-ins, 4 emerged as echoics, 1 was an echoic-mand and 16 independent mands. This suggests that both mand training and intraverbal training with stimulus-stimulus pairing can be effective in inducing first instances of speech in non-vocal children with autism though inferences about each components effect in terms of its necessity or sufficiency cannot be drawn.

There are individual differences amongst participants as to the time taken for vocalization, and the emergence of the first vocal, as well as all 7 instances of speech. With Huber, Rita and Junaid the first instances of speech started within 1-3 weeks of introduction of intervention whereas with Narvey, Lika and Hans acquisition started in the 6, 10 and 16th week of introduction of intervention. Cooperation in the case of Lika could be an initial barrier to learning. Junaid's initial two vocals emerged as intraverbal fill-ins in 8, and 17 days however, he did not acquire any further intraverbals and acquired mastery criteria (N=7 vocalizations) by acquiring independent mands on day 94. Junaid's initial vocals were emitted under the stimulus control of the antecedent verbal unit but not under motivating operation or the echoic-mand. Junaid's 3rd vocal "ball" (Table 11.7) emerged as an independent mand under MO and not as an echoic-mand. This could be one possible reason for the long delay in acquisition, and explains the acquisition of further 3 vocals under MO on the same day.

As with previous experiments, whether certain pre-requisite skills such as joint attention, co-operation or imitation being present in strength or the existence of barriers such as challenging behaviors, high rates of stereotypy can influence the outcome need to be studied. Future research can also consider addition of tact training and stimulus-stimulus pairing sessions in the intensive behavioral interventions for children with autism without any speech or low speech as the additive effects could make the package stronger.

Figure 4.2 Experiment 4

Effect of introducing a treatment package with non-vocal children with autism

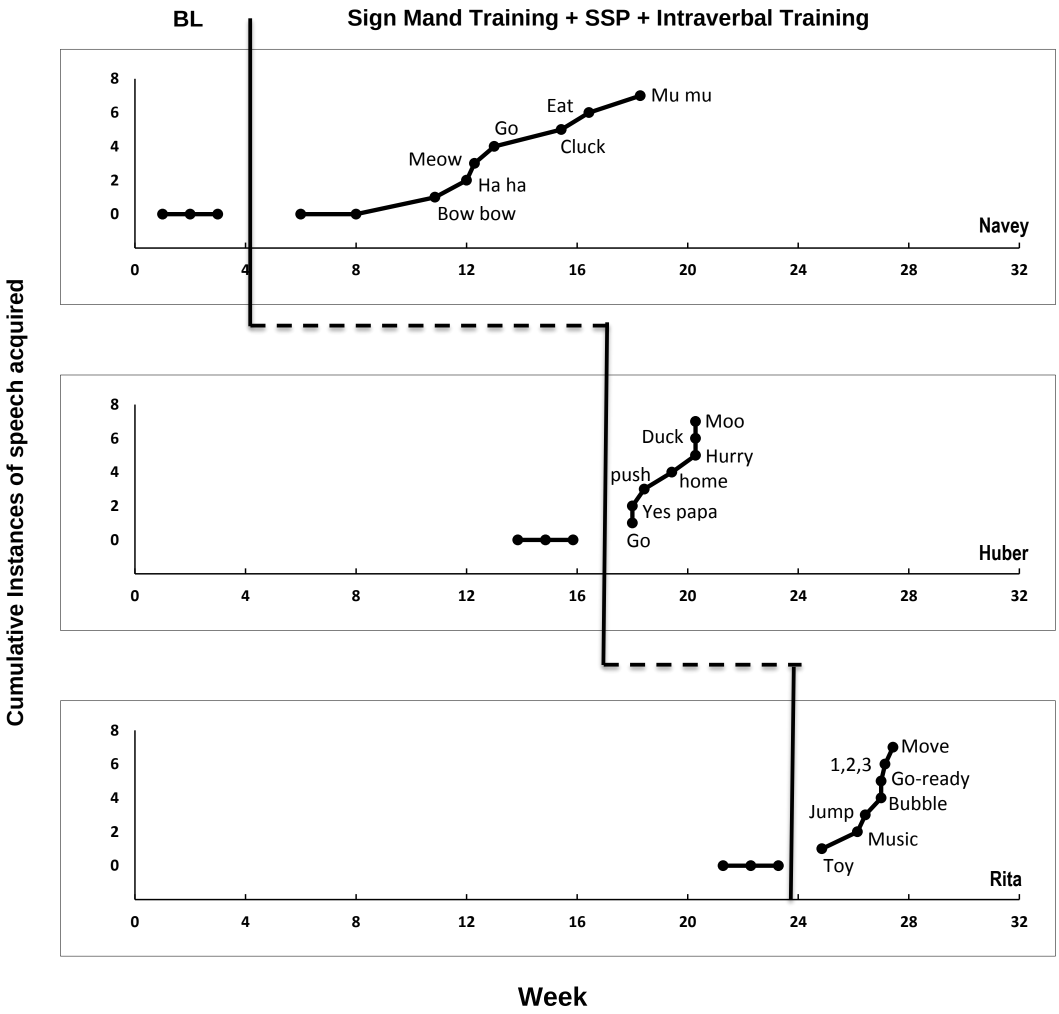


Figure 4.2: A multiple baseline across subjects to study the effect of sign mand training with SSP and verbal unit paired with vocal as a treatment package in children with autism.

Figure 4.3 Experiment 4

Effect of introducing a treatment package with non-vocal children with autism

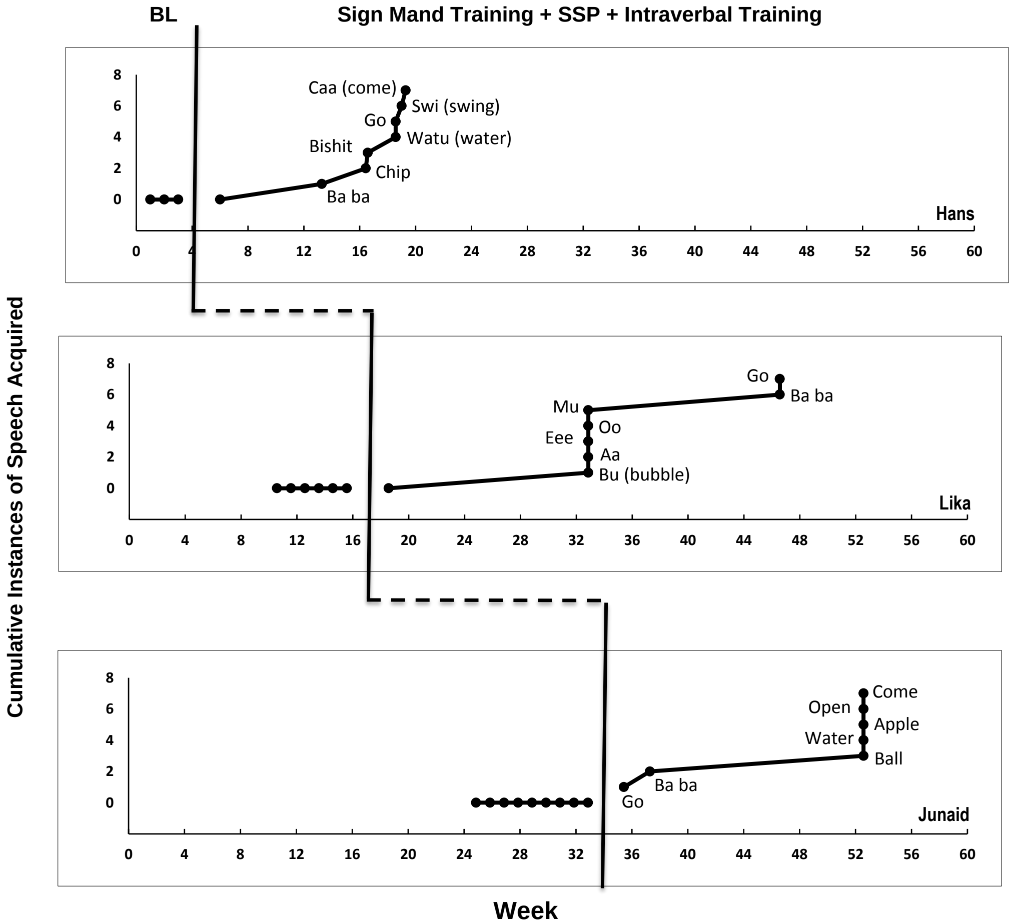


Figure 4.2: A multiple baseline across subjects to study the effect of sign mand training with SSP and verbal unit paired with vocal as a treatment package in children with autism.

Replications Experiment 4

Replications of Experiment 4 were conducted across 13 more participants, displayed on an additional 3 delayed multiple baselines, i.e. a total number of participants in Experiment (4.0-4.5) n=19. While data for the first 3 participants (MBL 4.2) and its replication (MBL 4.3) have been explained in detail above, other participants were added to the experiment as the previous participant acquired at least one instance of speech. Tables below (MBL, 4.1, 4.4, 4.5) provides details of participants on each delayed-MBL with regards to age, gender, and number of days to first vocalization as well as number of days until they met criteria (n=7 vocalizations). Full data sets including vocalization graphs are available in Appendix 3 (Figures 4.1, 4.4 and 4.5).

Each delayed MBL had 4-5 participants each. Of the total n=19 participants on this experiment, 17 acquired vocals while 2 remained non-vocal. Mean IOA on vocal emergence across all MBL's was 89% (Range 83% to 94%) confirming the emergence of vocalization.

Summaries of participants in Experiment 4 replication studies MBL 4.1, MBL 4.4-4.5: Age, gender, onset of vocalizations and time to meeting criterion.

MBL 4.1

Participant	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	SVE	4.4	F	30	87
2	KLA	1.11	M	14	92
3	JJO	4.11	M	0	0
4	KAM	3.4	M	12	34
5	SAG	1.8	M	10	29

MBL 4.4

Participant	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	CGO	3.0	M	15	75
2	RKAY	6.10	F	0	0
3	MMA	3.3	M	6	10
4	JRA	9.2	M	35	155

MBL 4.5

Participant	Name Code	Age	Gender	Days to 1st Vocal	Days to 7th Vocal
1	RGA	8.6	M	136	338
2	JBH	6.4	M	74	162
3	AAA	7.2	M	28	55
4	VKA	6.11	M	5	7

Results from 19 participants showed that, 17 (89%) participants emerged with vocals with the application of treatment package, presenting evidence of the success of the intervention. Data for 13 participants in the replication studies are presented in 3 delayed multiple baseline graphs (Figures 4.1, 4.4, 4.5) in Appendix 3.

Each participant on the delayed MBL (4.5) acquired vocalization to mastery criterion (n=7 vocalizations). One participant each on MBL's (MBL 4.1, MBL 4.4) remained non-vocal.

Early vocal acquisition

On the implementation of the intervention, emergence of vocalization was rapid in most children except two. Participants namely, SAG and KAM (MBL 4.1), CGO and MMA (MBL 4.4), and VKA (MBL 4.5) acquired vocalization mastery criteria between 7-34 days. SAG was a 1.8 years old boy with a baseline assessment score of 12 (BLA), whose first vocal emerged on day 10. His first two vocals /ba-ba/, and /moo/ were intraverbal fills for animal sounds. His next four vocals kurkure (a crispy snack), come, /chi/ for chips and pani (water) were independent mands, and his final vocal to meet mastery criteria was /three/, a fun fill-in when the therapist said "1, 2". SAG had a good rate of learning, and acquired many skills, to overcome core symptoms of autism and joined mainstream school. KAM was 3.4 years old with a baseline assessment score of 15 (BLA). He was cooperative and had some basic matching skills. KAM vocalized /bow-bow/ for "dog says" and /star/ when the rhyme "twinkle twinkle" was sung. On day 34 he achieved the mastery criteria with the remaining 5 vocals /o/ for rhyme fill-in "Old Mac Donald", /ne-ne/ for, "horse says", followed by echoics /ma/ and /pa/ on acquisition probes and an independent mand /go/ when he wanted to leave the work area to go to the play park.

A third participant namely MMA was 3.3 years old and received a diagnosis of ASD, while travelling to India. He was living in London prior to his diagnosis. MMA was a playful child and scored 13 (BLA) on baseline assessment; some vocal play was observed during the assessment. He acquired all his vocals /to-ta/ for water, /tee-saw/ for seesaw, /tum/ for come, /toe/ for toy, /pin/ for spin, /nusik/ for music, and /avi/ for carry; as independent mands within 10 days of intervention. The fourth participant VKA, had a baseline assessment score of 16 (BLA), and his vocals emerged within a week meeting the mastery criteria of using words under conditions of motivating operation to ask for his preferred items.

Participant CGO was 3 years old with a BLA score of 14 during baseline assessment. On the implementation of the intervention, he emerged with his first vocal mand, “music” on day 10, and took another 60 days for the remaining vocals to meet the mastery criteria. He acquired one more mand “jump”, while the remaining vocals emerged as intraverbal fill-ins for animal sounds and fun-fillins. It may be mentioned that, all participants SAG, KAM (MBL 4.1), CGO, MMA (MBL 4.4) and VKA (MBL 4.5) were highly cooperative which could be one of the precipitating factors leading to rapid acquisition and each participant emitted words with clarity.

Some other participants namely SVE and KLA (MBL 4.1) acquired their first vocal on 30 and 15 days while attaining mastery criteria in 87 and 92 days respectively. SVE was 4.4 years old, quiet child and appeared slightly anxious. She had negligible eye contact, and preferred to remain at the table. She acquired 2 mands and 5 intraverbal rhyme fill-ins. It was also reported that her learning rate was slow. KLA (MBL 4.1) was a 1.11 year old who cried for 2 days after he joined the study. He started vocalizing by filling-in animal sounds and later acquired vocal mands to meet the mastery criteria. AAA (MBL 4.5) was a 7.2 years old boy and his parents reported his previous intervention included speech therapy and occupational therapy. Participant AAA was cooperative, maintained eye contact, was able to match a few identical pictures and objects, follow a few receptive instructions like wave bye, and asked for preferred items by pulling hand and had a baseline assessment score of 23 (BLA). Once the intervention was started he acquired all vocals within 28-55 days; his first mand “jhula” was for swing and the remaining 6 vocals “bow”, “papa”, “star”, “little star”, “ba-ba” and “chuk-chuk” were rhyme and animal sound fill-ins.

Long delays in vocalization

Participants JRA (MBL 4.4), RGA and JBH (MBL 4.5) took the longest to acquire vocals on this study. Participant RGA was 8.6 years old with a BLA score of 12. He was non-cooperative, would cry often, made loud stereotypic sounds and would be constantly moving. He had spent 5 years at a special school prior to his enrollment in this experiment. A preference assessment conducted prior to target selection revealed, RGA did not prefer toys, edibles or play park items and therefore his target mands constituted mands for action from others. RGA's vocal emerged on day 136 and met the vocalization criteria in 338 days. His first vocal was /pus/ for pushing him on the swing which was contrived by holding the swing, /massa/ for massaging his arm, /go/ when he wanted to leave the chair, /piyo/ for pillow, to put his head down and rest, /moo/ for move which was contrived by blocking his way, as he wanted to move about, /no/ for refusing things he did not want, and /oni/ for asking for "onion". Post vocal emergence RGA acquired an additional 5 mands, and started responding to echoics. During a follow up conducted 2 years later his father revealed RGA had maintained some need based vocals as word approximations and was enrolled in a special school with day care facilities.

Participant JBH was 6.4 years old and had previously been receiving behavioral intervention in USA for nearly 2 years. His baseline assessment suggested he was able to sit for a few minutes, had limited eye contact and did not respond to name. He could identify 20 common items in pictures but could not identify any objects; he also exhibited many behaviors such as, crying, screaming, playing with saliva and tapping his fingers on surfaces. He received a baseline assessment score of 17 (BLA). JBH achieved his first vocal in 74 days as an intraverbal fill-in saying /o/ in response to the rhyme "Old Mac Donald". His next 5 vocals were mands /mm/ for music, /oo/ for open, /bu/ for bubbles, /pus/ for push when he was on the swing, and /foo/ for blowing bubbles; he acquired mastery criteria by filling in /a/ for star in the rhyme "twinkle-twinkle" in 162 days.

Participant JRA was 9.2 years old who lived in Bahrain where he was attending speech therapy, OT and ABA based therapy prior to his enrollment in this experiment. His baseline assessment suggested he was cooperative; he made requests by pointing, was able to imitate gross motor and fine motor movements but was unable to perform on oral motor imitations or echo. He could match identical pictures, and could receptively identify body parts, nouns, verbs and categories in pictures. Although JRA was using PECS for communication his parents consented to the introduction of sign mand training with SSP as he was not adept at PECS. JRA also had a younger sibling with a diagnosis with autism. He acquired first instance of speech in 35 days and met the mastery criteria in 155 days taking approximately 20 days on average to master each vocal. All his vocals emerged as intraverbal fill-ins.

Of the 19 particpants, JJO (MBL 4.1) and RKAY (MBL 4.4) remained non-vocal. JJO was 4.11 years and RKAY was 6.1 years old. Both had a history of speech therapy and OT and their learning rate at IBI was slow. Both had difficulties with auditory-visual discrimination and had acquired less than ___ signs in ____ weeks.

Summary

Experiment 4 and its replications demonstrate 80% participants responded to the treatment package i.e., mand training with SSP and vocal pairing with antecedent verbal unit (VU), and acquired first instances of speech at a rapid pace. The replications provide support to the effectiveness of using a treatment package for positive outcomes in developing vocalizations in non-vocal children with autism.

Summary N=144

The experiments reported here constitute a longitudinal study conducted with N=144 participants over a period of 6 years 8 months. All participants between the ages 1.4 – 13.5 years, were living in India. A final sample of N=126 completed the study, of which 122 non-vocal children with a diagnosis of autism participated in 4 delayed-multiple baseline experiments, while 4 participants participated in single subject A-B design studies, due to the fact that some of the participants in their study did not meet criterion or were not available for inclusion. Of the 18 non-vocal participants excluded from the study, eleven left the study in 6 months, six did not submit a diagnosis report, and one did not have an ASD diagnosis. One main multiple baseline experiment was explained in detail for Experiments 1-4 and replications for Experiments 1,3 and 4 were discussed for each experiment (Experiment 2 had only one MBL). Data for the replication studies are presented in delayed multiple baseline graphs (Figures 1.1-1.12, Figures 3.1-3.9, and Figures 4.1, 4.4 and 4.5) in Appendix 3. The master data table (T12, Appendix 2) includes each participant's demographics; including those who were not shortlisted for the study as well as those who left the study within 6 months. Table 12 was used to examine days to vocal emergence after the introduction of independent variable, verbal operants under which vocals emerged, time taken to acquire the 1st and the 7th vocal meeting acquisition criteria (n=7 vocalizations), the impact of age on vocal emergence, and type of vocalization.

Review of data collected from all n=126 participants provides insights into a variety of aspects of speech emergence. It can be concluded with fair evidence that speech did not emerge on its own, and the effect of maturation is unclear. The independent variables demonstrated experimental control across multiple baseline studies. Of the n=126 participants, 105 participants acquired vocals meeting the mastery criterion of seven vocals with permanent effects (Table 13).

Table 13: Final Vocalization Results Summary N=126

Total Participants	126
Vocal Acquisition	105
Remained Non-Vocal	21
% Vocal Participants	83%

The efficacy of the procedures was demonstrated across all four interventions. Two interventions (Experiment 1 & 2) included sign-mand training with vocal pairing with and without delay and two included the addition of a second independent variable i.e., pairing a target word with an antecedent verbal unit (VU) after a delay of minimum 12 weeks as the participant did not acquire vocals (Experiment 3) or as a treatment package (Experiment 4).

The following Table (Table 14) demonstrates all intervention were equally effective in inducing first instances of speech; 48 of 58 participants emerged with vocals in Experiment 1; and all three participants acquired vocals in Experiment 2. There were 46 participants in Experiment 3, and 37 of the 46 emerged with vocals; in Experiment 4, of the 19 participants 17 vocalized.

Table 14: Vocal Emergence By Experiment

Participants/Experiments	Expt 1	Expt 2	Expt 3	Expt 4	Total
Non-Vocal Participants	58	3	46	19	126
Acquired Vocals	48	3	37	17	105
Remained Non-Vocal	10	0	9	2	21
% Vocalized	83%	100%	80%	89%	83%

Age of Participant and Vocalization

A retrospective data analysis (Table 12, Appendix 2) demonstrates vocal acquisition among participants distributed by age. Participants can be divided in three groups; early intervention children below the age of 3 years, participants between 3-8 years and the older age group above 8 years. Data suggests (Table 15), that age of the participant was not a determinant of vocal acquisition and older participants had an equal chance of acquiring first instances of speech as early intervention participants. Interventions were equally effective across all ages and this provided some evidence that older children can also acquire consistent vocalization with mand and intraverbal training with SSP.

Table 15: Vocalization by Participant Age

Age in Years	Total Participants	Achieved Vocalization	% Vocal Participants
1.4 - 3.0	41	34	83%
3.1 - 8.0	79	66	84%
8.1 – 13.5	6	5	83%
Total	126	105	

There were 6 of 105 participants above 8 years of age participating in different experiments. Of these 6 participants, 5 acquired vocals including two of the oldest non-vocal participants at 12.2 years and 13.5 years of age, validating the success of the intervention. One participant Ann (code name) lived in U.K (consent from parent received for description) and had received behavioral intervention until the age of 11 years. Ann participated in this study in India at the age of 12.2 years as a non-vocal child. Her BLA score at intake was 22 and nil on the EESA. She was fairly cooperative and worked for short durations of 5-8 minutes with edible reinforcers in view. She was proficient in playing computer games, was able to match identical pictures. Ann used signs, to mand for 2 items and tact 4 items and imitated a few gross and fine motor movements. A detailed parent interview conducted prior to the intervention suggested she had exposure to mand and tact training using manual-signs however her previous intervention did not include pairing vocals although mand training was conducted under motivating operations. Ann engaged in some stereotypic vocal sounds that may be described as crying when she was denied tangibles. She was already on an IBI intervention when she joined the study. Ann (MBL 3.4, Appendix 3) started the intervention with mand training using manual signs with paired vocals and was on sign-mand training for 16 weeks before the second independent variable was introduced. She was on both interventions for another 19 weeks before her first vocal emerged at the age of 12 years 10 months. She achieved mastery criteria (7 distinct vocals) within a short span of 4 weeks after the first vocal emerged. Ann acquired sign mands prior to vocal emergence. Her first 7 vocals were all independent vocal mands proceeded by signs and were word approximations; /bubu/, /wa/, /no/, /opa/, /pi/, /TV/, and /u/ for bubbles, water, no, open, piano, TV and cashew respectively. Since completion of the study she has acquired 31 vocal mands like “come”, “show me”, “get up”, “blow bubbles”, 35 tacts, such as “flower”, “soap”, “pillow”, “pencil” etc., and 25 intraverbal fill-ins. Her speech clarity has improved considerably and she is able to use words to communicate although speech clarity remains an issue as confirmed through an assessment by a speech and language pathologist (report available with parents).

Ann emerged with first vocals after 35 weeks of stimulus-stimulus pairing however all her first 7 vocals emerged as mands. The intraverbal training appears to have facilitated the acquisition of vocals as it was introduced 16 weeks after mand training with paired vocals. The acquisition of manual signs could have acted as prompts for vocal acquisition too. All mands acquired were for edible items, which were not used during intraverbal training. It is possible Ann's previous learning history of using signs for mands had been reinforced and interfered with pairing effects. As intraverbal training excluded using signs and was consequated with non-edible reinforcers it can be assumed this distinction was established only after intraverbal training with paired vocals was introduced, leading to vocal emergence within 4 weeks.

Dako the oldest participant on the study at 13 years 5 months had no prior behavior analytic intervention and emerged with vocals in the 4^{th} week after the introduction of sign-mand training with paired vocal and took 24 weeks to be declared vocal. He has been described in detail in Experiment 1 as the fifth participant (MBL 1.0). His vocal approximations emerged despite many years of speech therapy, after the protocol sign-mand training paired with vocals was implemented. He acquired 1 sign-mand prior to his first 3 vocals and 2 more signs (book, open) following which correlated vocals /boo/ and /opu/ emerged. Dako left the behavioral intervention after he acquired vocals and not many details are available regarding his current vocal status. Results of both older non-vocal participants confirm the role of stimulus-stimulus pairing under conditions of motivating operations with one and the additive role of pairing an antecedent verbal unit with vocal pairing in in the second participant leading to vocal emergence.

Speech Emergence and Verbal Operants

A total of 105 participants acquired 7 vocals each and thus attained the mastery criteria during the present study. Vocals were achieved as independent mands, echoic-mands, echoics, and intraverbals. For some participants there was a stage before acquisition of vocal mands during training when vocalization emerged under echoic control after the paired vocal as echoic-mands. Such vocalization meets the definition of functional speech as it demonstrates echoic control under motivating operation. A study of vocal emergence by verbal operants in each experiment is presented below in Table 16.

Table 16: Total Vocals Emerged by Verbal Operants

Verbal Operants	Expt.1	Expt.2	Expt.3	Expt.4	Total
Echoic-Mand	99	0	81	8	187
Mand	187	18	41	48	294
Intraverbal	24	3	114	57	202
Echoic	26	0	23	6	52
Total	336	21	259	119	735

Data from Experiment 1 reveal (Table 16), 48 vocal participants (Table 14) acquired a maximum 336 vocals. Of these, participants predominantly acquired 56% vocals as independent vocal mands, and 29% echoic-mands. This strongly affirms the body of research suggesting motivating operation has a significant role in the development of verbal behavior. However on acquisition probes 7% vocals also emerged as intraverbal fill-ins for some participants on mand training. An example from participant "RRA" (Figure 1.2, Appendix 3) suggests during an acquisition probe conducted post vocalization when the experimenter said "Hip-Hip" and paused for 2 seconds "RRA" vocalized /hurray/; similarly another participant "MSH" (Figure 1.11, Appendix 3) when probed with the rhyme "twinkle twinkle little", vocalized /aa/ for "star". It may be noted that intraverbal training was not provided to the participants "RRA" & "MSH" in Experiment 1, hence initial vocal emergence as intraverbal fill-in could be the result of learning from the natural environment and requires further probing.

Another significant observation during the study of verbal operants was that only 8% vocals emerged as echoics. While participants vocalized target words as echoic-mands i.e., saying /wa/ after the paired vocal "water", under conditions of motivating operation, the participants rarely echoed a target sound such as "aa" or "ba" when the motivating operation was not in place and a vocal model was presented during acquisition probes after each vocal acquired. This clearly suggests initial vocals were not under stimulus control and were the result of stimulus-stimulus pairing.

During Experiment 2, a time-delay was introduced, as participants had not acquired vocals for 9-33 weeks with mand training and SSP. For all 3 participants 86% first instances of speech emerged as independent mands during the 5-second pause. It may be noted that 14% of initial speech sounds also emerged as intraverbal fill-ins. This observation needs further exploration.

Experiment 3 included 46 participants. Of these 37 acquired vocals (Table 14), after the introduction of intraverbal training i.e. the second independent variable. Data analysis of vocal by operant suggests (Table 16) the distribution as 16% independent mands, 31% echoic-mands and 44% intraverbal operants. Introduction of antecedent verbal unit paired with vocal, thus facilitated the emergence of vocals as a majority of vocals emerged as intraverbals. The role of intraverbal training with non-vocal children with autism needs further study. Only 9% vocals emerged as echoic trials conducted on acquisition probes, corroborating results from Experiment 1.

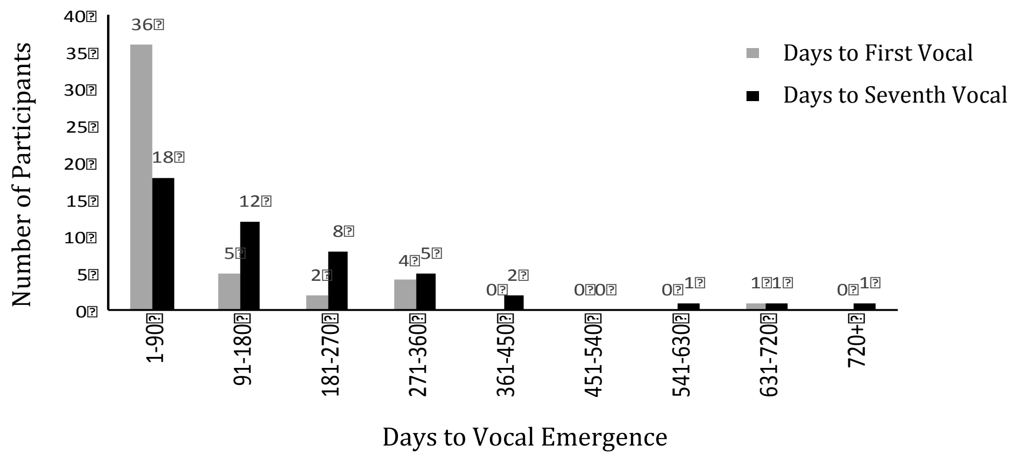
In Experiment 4 pairing of vocals was conducted under mand and intraverbal training conditions and evaluated for 19 participants. 17 participants (Table 14) first instances of speech emerged. For 89% of the participants 40% were independent mands, 7% echoic-mands, 48% intraverbal fill-ins and 5% echoics. These data are similar to Experiment 3 where the target word was paired with an antecedent VU and a high number of vocals emerged as intraverbal fill-ins and needs further investigation.

The failure of emergence of echoics as first instances of speech in the current experiments corroborates with previous research on echoic training (Esch et al., 2008). The low frequency of sounds produced at times in children with language delays provides difficulty for the use of shaping procedures. Studies using echoic training using shaping are time consuming and often lead to aversive situations for non-vocal participants. Echoic training provided by family members at home using natural parenting methods such as modeling might thus be ineffective in evoking vocals.

Interval to Vocal Emergence

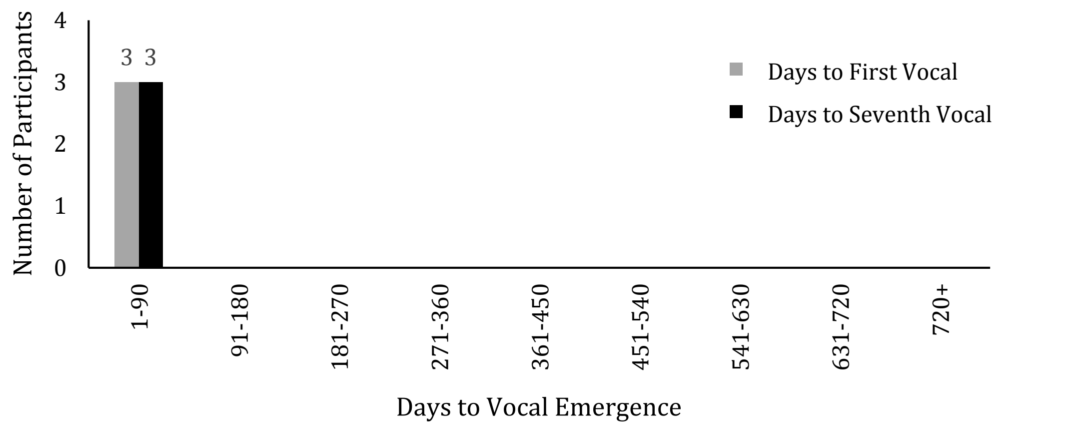
Vocal acquisition has been an important dependent variable studied in Experiments 1-4. Data record details for each vocal, acquired by each participant, have provided further information on vocal emergence patterns in each participant. Some participants demonstrated rapid acquisition, while some others had large intervals to mastery critera (n=7 vocalizations). An analysis of experiment wise data (Table 12, Appendix 2), for days to vocal emergence is graphically presented and discussed below (Figures 6 – 9).

Figure 6: Days to Vocal Emergence – Experiment 1



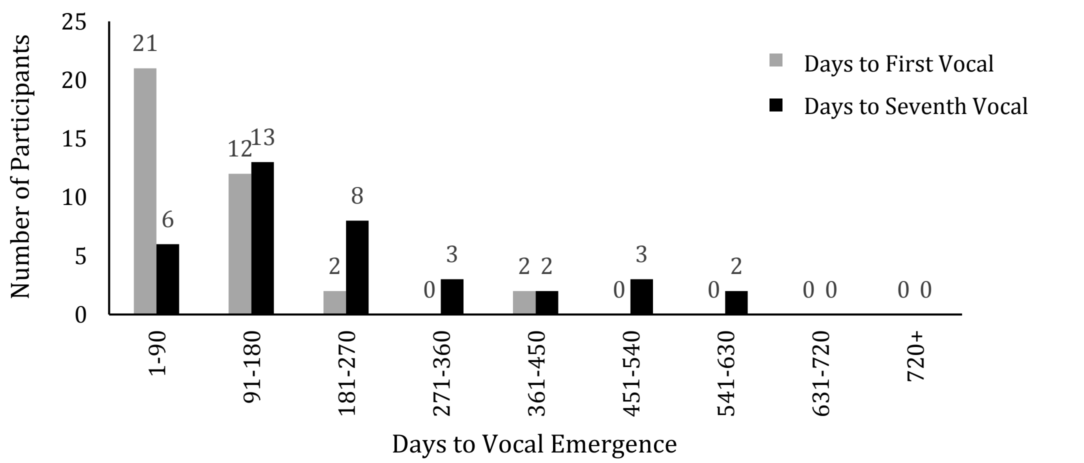
Experiment 1 included a total 58 participants, between 1.4-13.5 years of age on sign-mand training with SSP (Table 14); of these 48 acquired vocals; however there was a fair degree of variability in the acquisition interval of the 1st and the 7th vocal. There were 18 participants who emerged with vocals in the first month of introducing the independent variable on 6 target mands. Of these, 4 acquired all seven vocals in the first month taking an average 4 days for each vocal; this included the criteria of 5 consecutive vocal days for each vocal acquired. A visual analysis (Figure 6) of days to 1st and 7th vocal suggests in the first 90 days, a total 36 of 48 participants, emerged with their first vocal and half of these reached the mastery criteria taking an average 12 days to master each vocal. Of the remaining; 12 participants took 180 days i.e. 24 days for each vocal; while 13 participants took 365 days; 5 participants took a maximum of 24 months to acquire all 7 vocals. Participant "RDA" (Figure 1.8, Appendix 3) took the maximum time of 2 years. Mastery for each vocal required the participant to vocalize for 5 consecutive days, followed by an inter-observer agreement of 80% before the vocal was recorded as acquired. As vocals had to be consistent and stable; days to mastery should be reviewed with the above considerations.

Figure 7: Days to Vocal Emergence – Experiment 2



Experiment 2 included a total 3 participants, between 4.1-5.10 years of age; previously undergoing mand training with SSP for 9 – 33 weeks. On the introduction of time-delay during mand training, each participant demonstrated rapid emergence of vocals taking 35 – 63 days to meet mastery criteria. As described earlier in detail, the most significant of the three was Hipal, who had a long history of being on speech therapy and used approx. 13 signs fluently to mand for preferred items. Vocal emergence of 7 distinct instances of speech after the introduction of time delay, demonstrates the efficacy of using time delay during mand training for some participants.

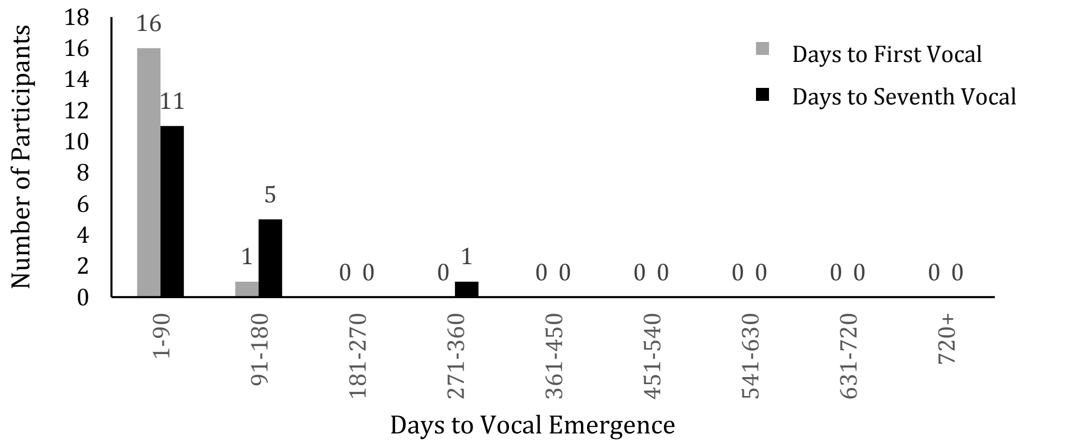
Figure 8: Days to Vocal Emergence – Experiment 3



Experiment 3 included 46 participants, between 1.8-12.2 years of age enrolled on mand and SSP training for 3-8 months without any change in their vocal status. The introduction of antecedent verbal unit paired with vocal (intraverbal training) as an additional variable, while mand training continued, led to vocal emergence. Visual analysis (Figure 8) demonstrates, 21 participants acquired 1st vocal in 3 months. Of these 2 participants met mastery criteria within 33 days; 3 participants took 60 days; and 1 participant took 76 days; taking an average 5-10 days for the acquisition of each vocal. In the following 90 days, a total 13 participants met mastery criteria; of these 9 participants took 14-20 days/vocal acquisition; while the remaining 4 participants took an average 25 days/vocal to achieve mastery criteria. Subsequently, 8 and 3 participants acquired vocal status in 270 and 360 days respectively. The remaining 7 participants (ASHE, APA, AV, NGA, AMAL, KGR & YDH) took an interval of 365-630 days to acquire vocal mastery criteria.

Further examination of data revealed, “AV” (Figure 3.8, Appendix 3) reached mastery criteria only after his vocals came under stimulus control; i.e. vocalizing with consistency; delaying the interval of vocal acquisition. Participant namely, AMAL (Figure 3.9, Appendix 3), took the longest interval of 622 days to reach mastery criteria. His first vocal mand /Aaa/ was a nasal squeaky sound, and his next 5 vocals emerged with long gaps ranging from 16-115 days between each. Anecdotal reports from parents suggested; an assessment by a speech and language therapist during this period; reported weak vocal musculature and recommendations for introducing a speech-generating device with immediate effect. As the family decided to wait, the intervention was continued. Within 6 months of his 7th vocal; “AMAL” started tacting, echoing, manding and using intraverbals fluently. He used words with clarity and stopped behavioral intervention. The case of participant AMAL, suggests pairing effects along with maturation, contributed to achieving vocalization despite the long interval. Both “AV” and “AMAL” later became a part of regular mainstream classrooms.

Figure 9: Days to Vocal Emergence – Experiment 4



Experiment 4 included 19 participants, between ages 1.8-9.2 years who underwent mand training with SSP, and antecedent verbal unit paired with vocal, as a treatment package. Visual analysis (Figure 9) indicates 16 of the 17 participants met vocalization mastery criteria, taking less than 90 days to emerge with vocalization. Of these, for 5 participants the interval for attaining mastery criteria (n=7) was less than 30 days; 5 participants took less than 80 days; and 3 participants took less than 94 days to attain all 7 vocals; taking an average 4-13 days for each vocal. Of the remaining; 3 participants took 155 – 162 days while one final participant took 338 days to attain mastery criteria.

It may be noted that participants in Experiment 4 took the least duration to emerge with vocals suggesting the effect of treatment package on vocalization.

Type of Vocals

Data recorded on the vocal emergence included transcription of the actual vocal along with the paired vocal. A detailed analysis of speech sounds, which emerged in non-vocal children with a diagnosis of autism suggests three types of vocal. These can be broadly categorized as phonemes, word approximations or words. Phonemes were initial sounds of a word, such as /bu/ for bubbles or ball, /tu/ for toy or top, and /ju/ for jump. Word approximations were words with omissions and substitutions, such as /jum/ for jump, /bunce/ for bounce, /fie/ for fries, /toff/ for toffee. Words were whole words spoken from beginning to end.

Table 17: Type of Vocals

Types of Vocal	No. of Participants
>=4 Words in First 7 Vocals	47
>=4 Word Approximations in First 7 Vocals	10
>=4 Phonemes in First 7 Vocals	38
<4 of Each Type of Vocal	10
Total	105

Data (Table 17) suggest 45% participant's first instances of speech included more than 4 clearly articulated words, 10% participants used word approximations and 36% participants vocalized phonemes like /ba/, /mu/, /op/ which required a context or items in view or a supporting sign to be understood.

Non-Vocal Participants

A total 17% participants i.e. 21 of n=126 (Table 12, Appendix 2) remained non-vocal across all experiments. Data analysis revealed, 15 non-vocal children spent between 7 months – 1 year on the intervention, while 6 participants (Table 12, Appendix 2), Ricky, "ASUR", "NYGA", "AJOS", "PKA" and "RKAY" (Figures 3.0, 3.4, 3.5, 1.11, 1.12 & 4.4 Appendix 3), remained non-vocal on the study for the entire duration from their date of joining till the end of study. The reasons for remaining non-vocal could not be identified despite similarities on the BLA. Ricky has been described in detail in Experiment 3. Retrospective study of data collected from their therapists and their records suggested a very slow rate of learning, and difficulties in discrimination. In 2.8 years "AJOS" (Figure 1.11, Appendix 1), acquired 23 sign-mands for communication; learnt to maintain eye contact for mands and instructions, followed 27 one-step instructions, identified 15 objects and 5 pictures of common use, and could follow 17 motor imitations and 32 imitations with objects; he continued to have difficulty in verb action and noun discrimination and had not mastered oral motor imitations; his biggest strength was in the area of visual performance as he learnt to match identical pictures and text-words. These suggest auditory visual discrimination difficulties and imitation could have impacted his learning rate.

Data from “PKAs” (Figure 1.12, Appendix 3) records suggested, in 2 years, he learnt to mand for 22 items by signs; receptively respond to 27 one-step instructions, identified all body parts, imitated 29 gross and fine motor movements including a few rhyme actions; and could confidently match many objects, pictures and sort by class. “PKA” however continued to have difficulties in object and picture identification with no targets achieved.

Participant “RKAY” (Figure 4.4, Appendix 3) had been on the intervention for 2.6 years. During this period she acquired 28 sign mands, learnt to maintain eye contact in different environments, responded to 29 one-step instructions, all body parts, and identified 29 objects, 26 pictures, 11 fruits, 8 colours and 4 items by function. She could tact 8 items by signs. RKA could imitate more than 50 motor imitations with and without objects in-group and during play and acquired oral motor imitations without vocal sounds. “RKA” could also match pictures, letters and words.

“NYGA” (Figure 3.5, Appendix 3) joined the intervention at the age of 2 years and was on Experiment 3 for 3 years. During this period he acquired 24 sign mands, 33 one-step instructions, 13 body parts, 28 objects, 16 pictures and 5 fruits. He also acquired 50+ object and motor imitations and was beginning to generalize imitations in-group. He mastered visual performance skills like matching identical pictures, categories and a few numbers and letters.

The learning details from IBI records (consent acquired) of the 6 non-vocal participants, suggests clearly, all participants acquired visual performance skills and imitation skills however listener responding was acquired at a slow rate and all except “RKA” had difficulties with auditory visual discrimination tasks. While imitation skills were acquired they did not generalize to oral motor imitation. Of the six participants, it was reported that two participants were placed on medication for reducing anxiety, mid-way into the intervention. It may therefore be concluded that, causes for lack of effect of stimulus-stimulus pairings were unclear. A possible cause to evaluate would be co-occuring conditions associated with the diagnosis of autism. Parents did not appear keen on a reassessment or an IQ assessment when requested for additional data.

Chapter 11: Discussion, Limitations, and Conclusion

Conclusion

Vocalization in children with autism has been a topic of considerable concern and study. A review conducted by Shillingsburg et al. (2015), on 13 published experiments on language delayed children (1996 – 2014) using stimulus-stimulus pairing suggests that pairing a specific vocal sound with the delivery of preferred items establishes the specific vocals as conditioned reinforcers. Although conclusions were not entirely supportive of stimulus-stimulus pairing (SSP) due to procedural variations between the studies included in the review, they provided enough evidence for it being an effective strategy.

Another systematic review on 78 behavioral, non-behavioral and mixed published studies conducted across five decades (1967 – 2015) by Mulhern et al., (2017) evaluated procedures responsible for induction of speech in persons with developmental disabilities including autism of which the 74.4% participants were on the autism spectrum disorder. A study of 63 behavioral intervention concluded that interventions derived from behavior analytic principles such as reinforcements, prompting procedures, shaping, stimulus-stimulus pairing had higher efficacy and supported language acquisition. Research rigor suggested 15.9% interventions were rated strong, 36.2% adequate, and 47.8% were weak. Most required rigorous empirical evaluations to be considered evidence based. Two non-behavioral interventions (Casenhiser, McGill, Morderer, & Shanker, 2015; & Dada & Alant, 2009) were not classified as evidence based due to inadequate or weak research rigor. While of the 7 mixed intervention studies none were evidence based. Various studies were found methodologically weak due to a lack of participant information, IOA, treatment fidelity or social validity.

The current study with n=144, of whom n=126 participated; 105 participants with autism gained from behavioral interventions and acquired vocals meeting criteria (n=7 vocals) contrasts with recommendations (Eldevik, Jahr, Eikeseth, Hastings & Hughes, 2010) that, children with autism may not benefit from behavioral interventions. Two major interventions implemented with 126 participants involved stimulus-stimulus pairing. In one, a target auditory vocal was paired under conditions of motivating operations (mands); and the second included, pairing an antecedent verbal unit (VU) with a target word. Results obtained provide strong evidence of the role SSP played in pairing neutral target sounds with preferred items and adds to the evidence from previous findings (Carroll & Klatt, 2008; Esch et al., 2009; Miguel et al., 2002; Smith et al., 1996; Sundberg et al., 1996; Ward et al., 2007; Yoon & Bennett, 2000). Previous studies (Caroll et al., 2008; Normand & Knoll, 2006; Shillingsburg et al., 2014; Yoon et al., 2007), reported that participants having low vocal verbal repertoire benefitted the most when stimulus-stimulus pairing was implemented; as compared to those with existing echoics or words in their repertoire. As all participants in this study were non-vocal, the pairing effects appear to confirm these findings.

It has been established that stimulus-stimulus pairing influences novel vocal responses (Esch et al., 2009) however, vocalizations emerged in previous studies had temporary effects (Miguel et al., 2002, Normand & Knoll, 2006). In the current study, one of the most important finding was the emergence of vocals in all participants i.e. n=105, with permanent effects. This was possibly due to a variety of reasons; firstly, pairing sounds, with carefully selected highly preferred items made through a systematic preference assessment in all experiments where mand training was implemented; and using these preferred items for pairing during intraverbal training; secondly, ensuring that satiation was offset due to changes in environment as the participants rotated between classroom, computer and natural environment like the play park area, which kept the value of the preferred item high during pairing trials with no opportunities for extinction; thirdly, conducting teaching trials only after participants demonstrated behaviors to indicate desire, i.e., motivation (Shillingsburg et al., 2015), such as looking at a desired item, or reaching for it; fourthly establishing the mastery criteria to achieve permanent vocals.

Mand training has been considered an effective strategy in improving vocalizations (Drash et al., 1999; Ross & Greer, 2008) in children with autism. Stafford, Sundberg and Bram (1988) discovered that, mand training produced stronger effects on the production of various dimensions of response due to the specific reinforcement associated with the mand in contrast with other verbal operants that were associated with non-specific reinforcement. While mand training studies entailed functional communication training to reduce challenging behaviors (Tiger, Hanley, & Bruzek, 2008) including sign-mand training (Falcomata, Wacker, Ringdahl, Vinquist & Dutt, 2013), manding for information with vocal children (Endicott & Higbee, 2007; Knapczyk, 1989; Lechago et al., 2013; Twardosz & Baer, 1973; Williams, Donley & Keller, 2000), and addressing various core deficits of autism (Mirenda, 2003; Charlop-Christy et al., 2002; Durand & Carr, 1991), behavior analytic literature for non-vocal mute participants with a diagnosis of autism has been limited. Previous researchers (Normand et al., 2011; Sundberg et al., 2001) have identified mand as the primary operant that benefits the speaker; and is a function of emergent verbal behavior. Mand training with SSP was implemented across all experiments and was highly effective in 3 of the 4 experiments..

During mand training, opportunities for teaching trials were created with preferred items kept in view, but out of reach (Drasgow et al., 1998). Verbal discriminative stimuli such as, “What do you want?” did not precede training trials to ensure training occurred under motivating operation and presence of the preferred item, without being dependent on supplementary stimuli (Charlop-Christy et al., 2002; Sundberg, 2005) presented by a mediator. Participants in all experiments learnt to initiate mands under conditions of motivating operations, by requesting in the presence of the item, using signs and vocals or vocals alone. While language training programs need to ensure that a mand repertoire is designed to develop spontaneous mands (Sweeny-Kerwin et al., 2007) i.e. requesting with items out of view, however, doing so early in the program may not be an effective strategy with young children, as inaccessible items within view may build the MO and induce behaviors which are observable, for conducting teaching trials. Spontaneous mands may preferably be taught, only after a large repertoire of signs have been acquired, and parents and instructors may continue to pair target words.

The substantial effects of motivating operation, SSP and direct reinforcement procedure were observed in experiments 1 and 4 and are consistent with previous research (Esch et al., 2005; Miguel et al., 2002; Smith et al., 1996; Sundberg et al., 1996; Yoon, 1998; Yoon & Bennett, 2000) as a sizeable number of children emerged with vocals within a few weeks of training (Table 12, Appendix 2). This suggests that, the vocalizations acquired a reinforcing function, as the auditory-paired stimuli, became conditioned through pairing effects (Yoon & Bennett, 2000).

Pairings during mand training occurred under contingencies of motivating operation, causing strengthening effects on vocalizations. The same processes seem to be in effect, when fun-fills, such as; "ready, steady" were paired with "go", due to the presence of motivating operations. However, in intraverbal training with animal sounds, the pairing effects did not involve motivating operations, and were possibly due to pairing with direct reinforcement.

Arranging the mastery criterion so that acquisition was declared only when five consecutive daily probes, prior to training sessions, yielded vocalizations, rather than immediate effects in vocalization post training, have resulted in permanent effects providing social validity to SSP procedures.

The selection of an AAC system has been attributed to individual variables, such as, pre-existing skills; individual needs and family preferences (Mirenda, 2005). While improvements in vocalization have been demonstrated in stage IV of using PECS (Carr & Felce, 2007; Tincani et al., 2004; Yoder & Stone, 2006); and mixed results obtained with the use of SGD (Olive et al., 2007; Roche et al., 2014; Schlosser et al., 2007). In the current study manual-sign training was selected as the unaided AAC due to cost factors, training efforts, and an overall limited response effort of preparing materials; with a resulting effect on ease of usage in young children. The current research provides strong evidence of using manual sign training under mand conditions during SSP with 105 participants of a total n=126 acquiring vocalizations. Data collected from one center on 13 participants (Table 20, Appendix 2) depicts 12 of the 13 participants acquired a range of 2 – 24 sign-mands prior to vocal acquisition. Acquisition of signs prior to vocal emergence has been described in detail in experiments 1-4. This supports previous studies (Tincani, 2004) that sign mands paired with vocals facilitated vocal acquisition, and signs acted as prompts for vocal emergence. Also, unlike previous studies (Ganz et al, 2002; Rose, Trembath, & Bloomberg, 2016), despite limited imitation skills, most participants acquired manual sign under conditions of motivating operations.

The number of pairings during stimulus-stimulus pairing has been considered a significant variable for increasing post-pairing vocalizations. Across studies, five paired the target word once per pairing trial (Miliotis, et al., 2012; Smith et al., 1996; Sundberg et al., 1996; Ward et al., 2007; Yoon & Bennett, 2000; Yoon & Feliciano, 2007); four studies paired the target sound thrice (Esch et al., 2007; Esch et al., 2009; Lepper et al., Rader et al., 2007), and another three paired it five times (Caroll & Klatt, 2008; Miguel et al., 2002; Stock et al., 2008), while no information was provided by Ward et al. (2007). Several other studies did not demonstrate an increase in vocalizations with 3, 5, and 7 times pairing per trial (Esch et al., 2005; Normand et al., 2006; Stock et al., 2008) presenting discrepant findings.

The current experiment included three pairings on each trial, during mand training; with preferred item delivered after two pairings, but before the third, under conditions of motivating operation. A minimum 40 trials per day were conducted on 6 selected targets. Thus each target was paired 6-7 times with approximately 18 pairings per target per day during sign mand training. Results suggest 25 of 58 participants took 5-18 days to acquire each vocal.

Pairing with antecedent verbal unit (VU) during intraverbal training has been a novel experiment with no previous research conducted with one pairing for each target. The antecedent verbal unit (VU) was paired only once, before the delivery of preferred items. For example a VU “cow says?” was followed by a 2-second delay, with the instructor saying, “moo” and simultaneously delivering the preferred item. A total 20 trials with 3 targets; i.e. 7 pairings per target were conducted daily. Results from the two experiments, which included intraverbal training, suggests, a high percentage (44-48%) of emerged vocals as intraverbal fill-ins (Table 16). The pairing for fun fill-ins was done within context such as; “ready steady go” being done on the slide or during a race, while animal sounds and rhymes were paired with preferred items. This supports previous findings for the use of one pairing for increasing vocalizations and provided added evidence with non-vocal children with autism.

Petersdottir et al. (2011) suggest that, the temporal distribution of pairings may play a role in vocalizations outcomes. While some studies have described this as the presentation of the target vocal thrice at a 1-second interval (Esch et al., 2009; Miliotis et al., 2012; Rader et al., 2014), others have not made any reference to this aspect of pairing (Stock et al., 2008; Sundberg, et al., 1996; Yoon & Bennett, 2000). In the current study, pairings during mand training included the presentation of the target vocal thrice at a 2-second interval (Experiments 1, 3, and 4) and once during intraverbal training, where the antecedent verbal unit was followed by a 2-second interval before the target word was presented with simultaneous delivery of preferred item. The salience of the auditory stimulus (Dinsmoor, 1995) produced effects leading to vocal emergence with emitted vocals closely resembling the paired auditory stimulus. Future studies need to focus on the temporal distribution of pairings to study if salience is a variable necessary for improving SSP effectiveness.

During these experiments, the particular preferred item with which the vocal was paired was never substituted for any other item or activity suggesting discrimination learning. For example, if the mand taught was requesting for music, the vocal emergence was always music or its phoneme /mu/ or an approximation /musee/ but never another mand, e.g., ball or any other word. Being in the presence of computer on which music was played could have become a discriminative stimulus for /mu/. Similar to mand training, the vocal that emerged following the VU “ready-steady” as an intraverbal fill-in was always “go” and never “moo” or any other word. Here the antecendent verbal unit “ready-steady” could have acquired discriminative properties and needs further exploring. One plausible explanation for such occurrence could be that, in previous studies (Yoon & Bennett, 2000) pairing occurred with a non-specific reinforcing stimulus such as physical interaction which included hand swinging, tickling or gentle poking in the stomach whereas the present experiments involved pairing specific preferred items during mand training and intraverbal fun fill-ins.

As stimulus presentation and salience is an important variable in learning; it needs mention that the pairing of vocal auditory stimulus was made without exaggerations or prosodic patterns (motherese; Falk, 2004). During mand training the pairing of the target word with the conditioned reinforcer was made with 2-seconds delay between each word paired in a loud, clear discrete voice. The presentations such as, “chips – 2 secs – chips – 2 secs – Sr+ delivery – chips” or “one, two – 2 sec – three” ensured salience of the auditory target stimulus. Hence stimulus salience may have led to the emergence of paired target words as phonemes, word approximation and words without substitution and requires further study.

The introduction of time-delay during mand training was primarily implemented because mand training with SSP did not yield vocals. A time delay of 5-seconds on declaration of motivation required the occurrence of a vocal response to a non-verbal discriminative stimulus (Charlop et al., 1985; Matson et al., 1990); which in this case was the motivating operation. The procedure differed significantly from mand training; the first pairing in this experiment was delayed by 5-seconds while the preferred item was in view but inaccessible. Delaying a prompt or withholding an object can increase the rate of responding (Hewett, 1965; Lovaas, 1966) and time delays can induce behavioral variability (Esch et al., 2002). Time delay in this case, challenged previous conditioning and when delays were introduced, it led to two of the three participants emerge with vocals within one week, despite 33 weeks of prior sign mand training with SSP. Experimental control was demonstrated through a multiple baseline design across three participants extending previous research (Carbone et al., 2010).

While some participants may benefit from an introduction of time-delay, the study does not address the question of whether an earlier shift to the time delay procedure have led to earlier emergence of vocal responses. While there have been many studies which have addressed stimulus-stimulus pairing, there have been very few published studies (Carbone et al., 2010; Charlop & Trasowech, 1991; Halle, Marshall, & Spradlin, 1979) which used presentation of delayed-auditory-stimulus method for increasing vocalizations, and none for non-vocal children.

The role of pairing a verbal unit (VU) with a target word (intraverbal training) was first evident in experiment 3, when it was introduced as a second independent variable with 46 children. 9 participants previously on mand training with SSP for 16 – 42 weeks acquired vocals within 2 weeks of introduction of intraverbal training (Table 12, Appendix 2). While some vocals emerged as mands and echoic-mands, data analysis clearly favours vocal acquisition as intraverbal fill-ins. Despite training with a higher number of trials under motivating operations, 45% first instances of speech were acquired as intraverbal fill-ins with half the number of trials in the two experiments where intraverbal training was implemented. This suggests pairing with preferred items had some role to play in vocal acquisition. This presents an interesting scenario requiring further study.

In experiments 1 and 2, where mand training was the only independent variable, acquisition probes revealed the emergence of a few vocals under the intraverbal operant. This supports anecdotal reports from parents outside this study, about children with autism filling in numbers and letters or singing rhymes while playing on iPad. These observations prompt further research on the role intraverbal training can play in the induction or emergence of vocalizations. The vocals emerged could possibly be non-functional initially, however these can later be taught as mands or tacts using transfer-of-stimulus-control procedures (Goldsmith, LeBlanc & Sautter, 2007).

The study of initial vocal acquisition as intraverbal fill-in has so far been completely ignored by researchers; and provides novel insight into the emergence of early language as fill-ins in non-vocal children with autism. Current published research on intraverbal training includes language development in children with autism with a pre-existing mand, tact and echoic repertoire (Ingvarsson & Hollobaugh, 2011; Sundberg & Michael, 2001) however these researchers did not include 100% non-vocal children with autism.

One of the core deficits of the autism spectrum disorder remains impairments in speech and language with nearly 25–50% remaining non-vocal (Anderson et al., 2007; National Research Council, 2001; Tager-Flusberg et al., 2005). Data analysis (Table 12, Appendix 2) on the type of vocal emergence, for participants from Experiments 1-4 suggests, 38 of 105 participants acquired early speech with >=4 phonemes (36%). A review of participants in Experiment 3, with many participants having delayed vocal acquisition and long intervals of first instances of speech suggests; 20 of 37 (54%) participants who met vocalization criteria had more than four phonemes in their initial 7 instances of speech. This is a fairly high number of participants with phonemic vocals, and need to be studied further by specialists in the field. While acquisition of speech has high social validity, the type of vocal emergence will have immense future ramifications on the quality of life and requires further investigation.

Behavior analytic literature is strewn with studies on early intervention and provides evidence on the significance of early intervention and its role in language development. Literature so far does not have enough data on vocal emergence in older children. During the present study 2 non-vocal older participants of 12.2 years and 13.5 years acquired first instances of speech enumerating the benefits of SSP on older non-vocal participants. One 13.5-year-old participant, namely Dako, acquired vocals under motivating operations with sign mand training and SSP; the other 12.2 year old participant, namely Ann, benefitted with the addition of pairing with antecedent verbal unit. Data obtained from children between 1.4 - 3 years of age who met criteria for vocal acquisition suggest 32 of 39 young children acquired vocals while 7 of them (Table 12) remained non-vocal. Although more evidence is required to support the success of SSP among older participants, there is also a need to identify reasons for some very young participants who did not vocalize.

A study of data (Table 12) regarding the interval of vocalization to mastery criteria (n=7 vocalizations) suggests apparently long intervals between the first and the seventh vocal. This may be explained by considering various factors; firstly, the mastery criteria required consistency in the acquisition of each vocal; i.e. post pairing; the consistent vocal emergence on daily probes across five days followed by inter-observer agreements; this could have delayed the declaration of acquisitions. Secondly, for pairing effects to be permanent (n=7 vocals), acquisition in 105 days would signify 10 days of pairing opportunities and 5 days of first trial consistent responses for each vocal to be considered acquired; making it appear much longer than it actually was. Thirdly, breaks during weekends could have contributed to delays; such as, 4 daily probes (Tuesday to Friday) followed by a weekend would delay mastery if on the day after a weekend, the participant did not respond during the first probe. The above considerations could provide possible reasons for long intervals in achieving mastery criteria. Another reason for long intervals could have been weak vocal musculature of the participants as evident from nearly 36% participants using more than 4 phonemes during the initial 7 vocals.

Individual differences in participants emerged during the study despite the score of Level 1 or Level 2 on the Behavioral Language Assessment (BLA). Baseline assessments demonstrated most participants with limited eye contact, weak imitation skills, and negligible vocal play. The assessment provided a fair amount of information about child's skills level on 12 domain areas however could not provide a basis for individual differences such as rates of skill acquisition. The possibility of existence of co-occuring conditions and other individual differences cannot be ruled out, in those having a diagnosis of autism spectrum disorder, leading to variance in skill acquisition rates.

This study provides experimental control specially in Experiments 1,2, and 4 and with limited extent in Experiment 3, for evoking speech in a large population of non-vocal children with autism. Emergence of vocals demonstrated in these experiments provides initial steps, for using shaping, to improve the quality of verbal behavior in those emerging with phonemes as first vocals (Esch et al., 2005). Various other strategies such as transfer trials (Arntzen & Almas, 2002; Petursdottir, Carr & Michael, 2005; Wallace, Iwata, & Hanley, 2006) can be used for the development of verbal behavior.

In the end an intervention with a high index of social validity and social significance contributes to the wellbeing of the individual and society. Speech emergence is one of them as anecdotal data from families suggest feelings of hope and happiness when they see their child vocalize.

Recommendations:

There is considerable need to provide a clear definition of non-vocal in the literature, due to the inclusion of participants, with up to 10 recognizable functional sounds (Drash et al., 1999; Paul et al. 2013; Yoder & Stone, 2006). While this point has been discussed in detail in Chapter 1; it needs to be highlighted that the lack of clarity in the definition of the term 'non-vocal' creates confusion due to the significant difference between a non-vocal child with no speech and a child with some ability to echo or use a few words. Various studies included some participants with no speech sounds while some others on the same study with few speech sounds (Paul et al., 2013; Tsiouri & Greer, 2003) with varying outcomes. Clearly, interventions for children who have a few vocals differ significantly from those without any ability to echo after a vocal model. The ability to repeat a vocal model using phonemes, word approximations or complete words cannot be considered similar to the lack of ability to do the same and behavior analytic literature needs to review this.

There is also a need to provide a rigorous and narrow definition of the term “speech” (Mulhern et al., 2017) due to the existing ambiguity in the use of the term (Subramanian & Wendt, 2010) and may refer to functional, spontaneous, echoic, stereotypic or non-contexual speech. Functional speech is contextual and serves the purpose of speech that may be used to mand, tact, fill-in intraverbally as required by both the speaker as well as the listener and may include spontaneous speech initiated by the speaker or be in response to another individual initiating communiation. Non-vocal individuals with autism, who acquire vocalizations as echoic repertoire, may initially echo after a model which may not serve functionality however early vocalizations may eventually lead to functional speech with behavior analytic procedures such as shaping (Mulhern et al., 2017). Thus the term speech needs future amendment to describe vocalization.

The current study provides substantial evidence in the use of stimulus-stimulus pairing and its effect on vocal emergence when sign mand training was implemented under conditions of motivating operations. Families of non-vocal children need to be trained and involved in implementation of these scientific procedures for improving the possibilities of outcomes.

The benefits of SSP and sign mand training provide enough documentation (Bartman & Freeman, 2003; Sigafoos et al., 2004; Tincani 2004; Sundberg et al., 1996); however often, parents and clinical practitioners avoid its practice due to the fear that it would obstruct the development of vocals. The current study adds to literature as first instances of speech emerged (83%) in a large population. The pairing with antecedent verbal unit provides a novel procedure for further research.

Sign mand training for early learners needs to be implemented with items in view and out of reach for contriving motivating operations for teaching trials.

Intensity of mand trials need to be high with possibly lesser than six targets for improving pairing effects while avoiding the use of supplementary discriminative stimuli such as “what do you want?”.

Antecedent verbal stimuli with paired vocals (intraverbal training) should preferably be initiated along with mand training as a treatment package for better outcomes as demonstrated in experiments. Caregivers in early years of vocal development often provide social reinforcement for vocal emittance. When early sounds acoustically similar to these vocalizations appear, they may automatically reinforce vocal behavior (Bijou & Baer, 1965; Schlinger 1995). As early sound emergence in non-vocal children with autism is essential to future speech production, oral motor exercises under the supervision of speech and language therapists may add to vocal emergence using SSP. This area of study needs further exploration.

With the high number of non-vocal children with autism and many clinics having wait lists intervention may be delayed. There is thus a need to empower families for an early start hence the following guidelines are provided for parents and clinicians.

Manual For Parents, Educators & Clinicians

Families of non-vocal children with autism are often faced with a deluge of treatment options. The following recommendations are based on evidence derived from the current experiments as well as peer reviewed behavioral interventions (Mulhern et al., 2017; Shillingsburg et al., 2015) in which a variety of variables have reliably demonstrated emergence of vocalization in non-vocal children with autism.

The following guidelines for parents, educators and clinicians may be practiced by those working with non-vocal individuals with a diagnoses of autism.

1. Target selection for mand training
   Considering the significant role of motivating operations during communication, the selection of target words has prime importance.
   a. A systematic preference assessment is the first step for identifying target items. Items or actions for which the non-vocal individual demonstrates

motivation several times per day should be listed and ranked. From this exhaustive list brief preference assessments should be conducted prior to teaching.

b. Approximately 6-8 targets may be selected, which can be practiced intensively (50-100 trials) several times in a day. As one target is achieved a new target may be added after conducting a preference assessment.
c. Stimuli with a high degree of auditory variance are considered best as initial target words. For example “bus” and “biscuit” sound fairly similar and should be avoided initially as the auditory output is less discriminable.
d. Stimuli may be selected from different environments such as an edible, a drink, a toy and a few verb actions, such as; asking others to open, blow or push. If the participant has limited preferences such as only edibles it would be best to avoid selecting targets from the same stimulus class.
e. While selecting teaching targets there is need to be as specific as possible. For example teaching words like “give”, “help” are generic terms as compared to teaching “apple”, “jump”, or “come”.
f. A drop in interest in any previously selected target should trigger another preference assessment.

2. Sanitizing the environment

   Communication training begins when the individual exhibits behaviors demonstrating motivation towards particular items. An item within reach may be grabbed or taken without requesting. Hence it is best to:

   a. Keep preferred items within view, however out of reach thus avoiding free access and creating an opportunity to observe and act on a teaching opportunity.
   b. It also ensures access to preferred items occurs with mediation.

3. Communication mode

   a. Before the introduction of training sessions it is important to select the most appropriate mode of communication. Families make a choice between manual-sign training, picture exchange system and speech generating devices. While research supports PECS training for emergence of vocals in stage IV and V, and a few participants emerged with vocals when SGDs were used for communication; however, the success of the current study in vocal emergence and the comparative ease of using manusal-signs is an important factor in recommending training using manual-signs.

b. Prior to using manual-signs, parents and clinicians need to identify signs that will be paired with the target word. Signs may be selected from stardardized systems (ASL or Makaton).
c. At times the sign selected may be complicated and the individuals motor abilities may provide learning constraints; in such an event the manual-sign selected may be modified to meet the individuals needs.

4. Data taking

   To monitor intensity of teaching and progress in learner a data collection system should be planned.

5. Contriving situations
   a. Contrive situations through the day to create teaching opportunities. For example keeping a favourite toy in a transparent jar so the learner can demonstrate clear motivation and an opportunity can be contrived to teach to say "open".
   b. Learning opportunites may range from a minimum 100 – 500/day to provide enough practice trials for communication.

6. The sign-mand protocol with SSP
   a. Once the learner demonstrates motivation the manual-sign should be prompted This has been enumerated in detail in experiment 1.

Limitations and Future Research

While the outcomes of the study have been positive there have been several limitations, which need to be addressed in future research. First, during the current research, data were collected on permanent vocalizations and recorded on first probes on all targets. While data were collected to focus on vocal acquisition with permanent effects; it did not demonstrate immediate effects of stimulus-stimulus pairing. While some efforts were made to record every vocal emergence, data monitoring for multiple children across locations was not found feasible and abandoned. Future studies may address the increase in vocalizations vis-a-vis acquisition in non-vocal children by a) modifying data collection methods. This may be done by, recording each vocal emergence; and analyzing trends and rate; as well as conducting probes with higher intensity rather than post vocal acquisition; b) defining vocalization mastery; by reducing the number of vocals acquired from n=7; as this resulted in continuing on the study for many weeks.

Second, some limitations could be related to the design of the experiments. An attempt could have been made to return to baseline to study the effect of the independent variable. This was not attempted for two reasons: one, the design included implementing the independent variable on the next available participant once a previous one acquired at least one vocal. A return to baseline could have hampered this and delayed mand training. Future research may explore this option.

A third limitation was the delay in introduction of the 2nd independent variable in experiments 2 and 3. In experiment 2, the first intervention was stopped and a time-delay was used after Ashar and Hipal had been on manual sign-mand training for 33 weeks however some improvements could be due to maturation effects. In experiment 3 intraverbal training was introduced among the participants between 27-42 weeks while the first intervention continued. There were likely serious confounds in Experiment 3 and the addition of the independent variable (i.e. intraverbal training with vocal pairing) may or may not have directly led to vocal emergence. Among other factors, maturation, effect of SSP included in both independent variables, intensity of trials, could have played a role in vocal emergence.

The experiments studied the effect of SSP during mand and intraverbal training and recorded consistent vocalizations as independent mands, echoic-mands, echoics or intraverbal fill-ins with permanent effects and resulted in higher social validity. Acquisition probes conducted did not demonstrate vocal emergence as tacts. Future research may consider including pairing tacts as target words in the presence of objects and pictures with or without signs with non-vocal children.

Results from Experiment 2 using time-delay as an independent variable showed high effectiveness (Godby et al., 1987) in inducing vocalizations; replicating previous research (Carbone, et al., 2010) with minor modifications, however, there was no specific criteria to identify children who could have benefitted with time-delay tactics. Further research is required to identify participant criteria, such as, an ability to accept delays, effect of delays on motivating operations, and the interval of time delay as a variable for evoking vocals. The experiment had limited generality. Future research can address these variables.

Pairing the antecedent verbal unit (intraverbal training) contributed to the development and emergence of vocals in many participants. Future researchers need to study this variable in detail with further modifications. Due to ethical considerations intraverbal training cannot precede mand training due to the significance of mands for the development of communication. Second, intraverbal training cannot be applied as an isolated independent variable for the same reasons. Third, once mand training is initiated, there can be no return to baseline. Fourth, mand training cannot be stopped at any time during the intervention. This was a serious limitation of experiment 3. Future studies may address this issue with better rigor.

Of the total 126 participants, 21 (17%) remained non-vocal. Of these 6% were less than 3 years of age, 10% were 3.1-8 years old while 1% were 8.1-13.5 years old. Child specific variables could not be identified for their non-vocal status. Autism diagnosis did not measure for severity and was a limitation as it could have highlighted child specific variables. Further research is therefore necessary to study autism severity, precursors to low learning rates, comorbidities, anxiety and cognition; so appropriate technologies may be selected for effective outcome.

Finally, the present research demonstrated that non-vocal children with a diagnosis of autism can be taught to vocalize functionally. Previous research on stimulus-stimulus pairing has been highly effective in the emergence of vocals across young and older age groups. Applied behavior analytic procedures, such as motivating operations and stimulus-stimulus pairing, play a major part in this development. These finding challenge researchers to develop even more effective procedures and provide hope to parents and professionals who work with non-vocal children with autism.

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Appendix 1

Forms

Parent/Guardian Information Sheet

Principal Investigator: Ms. Smita Awasthi, BCBA

Your child has been selected to participate in a study titled "Emergence of vocalization in non-vocal children with autism" being carried out as part of a Ph.D. thesis in the School of Education at Queen's University Belfast. Before you decide to participate in this research, it is important for you to understand what the purpose of this research is, and what it will involve. Please take as much time as you need to read it. If there is anything that you are not clear about, I will be happy to explain it to you.

Thank you for reading the following information.

Autism Spectrum Disorder is associated with difficulties in learning to communicate using vocals. Despite serious attempts by parents, many children are unable to learn to vocalize. This may lead to behavior problems and impose limitations in socialization while causing stress to parents.

The purpose of this study is to replicate researched and successful behavioral interventions known to induce or increase vocalizations in non-vocal children in the autism spectrum. This research will include non-vocal children who will be taught communication using signs under the child's motivation. Research has shown that augmented communication in the forms of signs is effective in increasing vocalization in children with very low functional speech. The activity of teaching the child to request for preferred items will be conducted in natural settings where your child will be most comfortable. Additional research based methods such as providing rewarding consequences for filling in rhymes and pairing words with preferred items or activities could also be explored.

Where will this study take place?
The study will take place at "Behavior Momentum India's" intervention center where your child is enrolled for undergoing Intensive Behavioral Interventions. The training will continue as long as your child is enrolled or till the first seven vocals emerge as per criteria. Periodic reviews will be made and discussed with you during case-meetings once a month.

Possible Risks and Inconveniences

There are no health or safety risks to the participants in the study as all teaching is under positive reinforcement.

Benefits / Cost / Compensation for participating in this study

This study is evaluating protocols, which have in the past led to to improvements in vocalization in non-vocal children with autism including those who have had speech therapy and have no vocals. While all efforts will be made to replicate research there is however no guarantee that vocalizations may emerge. There are no additional costs for participating in the study and no compensation is envisaged for participating in the study.

Your Child's Rights

During the research project, you, the client (or client guardian) and your child have the right to considerate respectful treatment, in a humane, physical, and psychological environment. Treatment will take place in a non-discriminatory manner, regardless of sex, religion, creed, color, or origin. You have the right to full information at any time in the treatment.

Confidentiality

All information concerning you and your child's participation in this program is private and Confidential, with the exception of any legally required reporting as mandated under child protection laws in India. Release of any of your information requires your written consent. Any results or information gathered will be securely stored. The information collected in this research study will be stored in a way that protects your child's identity. Each participant will be provided a unique ID number and details of each participant will be documented separately to all data

collected. Original data files will be stored securely in the custody of the researcher for five years after completion of the thesis.

Who will have access to the information collected during this study?

The researcher will have access to data and information about your child. These will be shared with you during monthly meetings.

Withdrawal from the study

You can choose to stop your child participating in the study at anytime for any reason. Please inform the researcher of this intention in writing and the program will be discontinued. Your child will not suffer any prejudice or penalty by your decision to stop his/her participation.

Further Information

If you would require further information or have any concerns about this study you may contact Smita Awasthi at +91-7760011700 or on her email ID, smita.awasthi@behaviormomentum.com.

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Thank you very much for participating in this study.

Parent/Guardian Consent Form

"Emergence of Vocalization in Non-Vocal Children with Autism"

Participant: ________________________________

Please initial box

□ I confirm that I have read the information sheet for the above study and have had the opportunity to ask questions.

□ I am satisfied that I understand the information provided and have had enough time to consider the information.

□ I understand that my child's participation is voluntary and that I am free to withdraw my child from the study at any time, without giving any reason, without our legal rights being affected.

□ I agree to allow my child take part in the above study.

______________________	_____________	______________________
Name of Parent/guardian	Date	Signature of Parent/guardian
Smita Awasthi	March, 10, 2010	
______________________	_____________	______________________
Researcher	Date	Signature

BEHAVIOR MOMENTUM INDIA (P) LTD.
407, 7th Main, 80 ft Road, HRBR Layout, Bangalore – 560043

Monday, 1st March, 2010

Sub: Consent to Smita Awasthi, for Vocalization Research on Non Vocal Children with Autism

In consideration of the benefits that will accrue to children and families affected by autism and upon your request, I can confirm that consent is hereby given to Ms. Smita Awasthi, Board Certified Behavior Analyst and External PhD student with Queens University, Belfast, Ireland; to conduct research in the Behavior Momentum Organizations premises subject, be involved with staff training and all that is required for such research being governed by the national policies on human research, ethical conduct guidelines of Behavior Analyst Certification Board, legal and regulatory frameworks in India.

Admin Manager
Behavior Momentum India

FORM 3

Therapist Training & Competency Assessment Form

Therapist name :___________________
Supervisor 1 ________________ Supervisor 2 _______________ Dates :________|__________|________

Supervisor scores appropriate box for each item based on direct observation during role play.

CRITERIA FOR PASSING: 80% CORRECT
SUPERVISOR RE-TRAINS and RE-ADMINISTERS ASSESSMENT IF % SCORE IS BELOW 80%

Instructions:

Supervisor administers the competency assessment in role play by observing for 30 minutes on 3 different occasions. For each item involved in the observation, the supervisor scores a (+) if the behavior is implemented correctly, a (-) if the behavior is implemented incorrectly, Observer 1 and Observer 2 will use different Forms.

	Score +/-		
Demonstrate the following	+/-	+/-	+/-
Mand Trial			
Tact Trial			
Echoic Trial			
Intraverbal Trial			
Free Operant Preference Assessment			
MSWO			
Capturing Motivation			
Contriving Situations for teaching mands			
Prompting			
Prompt Fading Trial			
Delivering a consequence			
Frequency and Duration Data Taking			
PERCENT CORRECT			

FORM 4

Ethical Guidelines for Trainers & Code of Conduct:

1. The interests of the child will always come before all other concerns.

2. Complete confidentiality will be maintained by each Behavioral Trainee. Children will NOT be discussed with anybody inside or outside the premises.

3. Behavioral Trainees / trainers will under all circumstances maintain honesty in implementation of procedures, data-collection, and the maintenance of data.

4. Rude tones or physical punishment towards a child will NOT be used at any time.

5. All data will be kept confidential and filed as per instructions.

6. All instructions given during the research will be adhered to strictly. In case of any confusion feel free to contact the Researcher.

7. No trainer will take any materials, papers, data sheets, research materials (hard & soft copies) out of the center at any point of time.

8. No photographs/ videos, audio recording will be made of the children at any time. This is strictly against the Ethical guidelines.

9. Children will be handled with sensitivity and a fun and happy environment will be created for teaching target skills.

I have read & understood the guidelines and all information provided. I agree to abide by them.

Name: Date:

Signature

The Behavioural Language Assessment Form
By Sundberg & Partington (1998)

Participant Code: _______ Participant ID: _______ Age: _______Date: __________

Assessors : ____________

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

For the following question, indicate the level of performance that best describes the learner's typical level of performance.

I. COOPERATIONS WITH ADULTS _________ (enter score).
How easy is it to work with the child?

1. Always uncooperative, avoids work, engages in negative behaviour.
2. Will do only one brief and easy response for a powerful reinforcer.
3. Will give 5 responses without disruptive behaviour.
4. Will work for 5 minutes without disruptive behaviour.
5. Works well for 10 minutes at a table without disruptive behaviour.

II. REQUEST (MANDS) ________
How does the learner let his needs and wants be known?

1. cannot ask for reinforcers; or engages in negative behaviour
2. pulls people, points, or stands by reinforcing items
3. uses 1-5 words, signs or pictures to ask for reinforcers
4. uses 5-10 words, signs or pictures to ask for reinforcers
5. Frequently requests using 10 or more words, signs, or pictures.

III. MOTOR IMITATION __________
Does the learner copy actions?

1. cannot imitate anybody's motor movements
2. imitates a few gross motor movements modelled by others
3. imitates several gross motor movements on request
4. imitates several fine and gross motor movements on request
5. easily imitates any fine or gross movements, often spontaneously

IV. VOCAL PLAY ________

Does the learner spontaneously say sounds and words?

1. does not make any sounds (mute)
2. makes a few speech sounds at a low rate
3. vocalizes many speech sounds with varied notations
4. vocalizes frequently with varied intonation and says a few words
5. vocalizes frequently and says many clearly understandable words

V. VOCAL IMITATION _________

Will the learner repeat sounds or words?

1. cannot repeat any sounds or words
2. will repeat a few specific sounds or words
3. will repeat or closely approximate several sounds or words
4. will repeat or closely approximate many different words
5. will clearly repeat any word, or even simple phrases

VI. MATCHING TO SAMPLE ______

Will the learner match objects, pictures and designs to presented samples?

1. cannot match any objects or pictures to a sample
2. can match 1 or 2 objects or pictures to a sample
3. can match 5 to 10 objects or pictures to a sample
4. can match 5 to 10 colours, shapes, or designs to a sample
5. can match most items and match 2 to 4 block designs

VII. RECEPTIVE _________

Does the learner understand any words or follows directions?

1. cannot understand any words
2. will follow a few instructions related to daily routines
3. will follow a few instructions to do actions or touch items
4. can follow many instructions and point to at least 25 items
5. can point to at least 100 items, actions, persons or adjectives

VIII. LABELLING (TACTS) __________

Does the learner label or verbally identify any items or actions?

1. cannot identify any items or actions
2. identifies only 1 to 5 items or actions
3. identifies 6 to 15 items or actions
4. identifies 16 to 50 items or actions
5. identifies over 100 items or actions and emits short sentences

IX. **RECEPTIVE BY FUNCTION, FEATURE, AND CLASS _________**
Does the learner identify items when given information about those items?

1. cannot identify items based on information about them
2. will identify a few items given synonyms or common functions
3. will identify 10 items given 1 of 3 functions or features
4. will identify 25 items given 4 functions, features, or classes
5. will identify 100 items given 5 functions, features or classes

X. CONVERSATION SKILLS (INTRAVERBALS) _______
Can the learner fill-in missing words or answer questions?

1. cannot fill-in missing words or parts of songs
2. can fill-in a few missing words or provide animal sounds
3. can fill-in 10 non-reinforcing phrases or answer at least 10 simple questions
4. can fill-in 20 phrases or can answer 20 questions with variation
5. can answer at least 30 questions with variation

XI. LETTERS AND NUMBERS _______
Does the learner know any letters, numbers, or written word?

1. cannot identify any letters, numbers, or written words
2. can identify at least 3 letters or numbers
3. can identify at least 15 letters or numbers
4. can read at least 5 words and identify 5 numbers
5. can read at least 25 words and identify 10 numbers

XII. SOCIAL INTERACTION ________
Does the learner initiate and sustain interactions with others?

1. does not initiate interactions with others
2. physically approaches others to initiate an interaction
3. readily asks adults for reinforcers
4. verbally interacts with peers with prompts
5. regularly initiates and sustains verbal interactions with peers

FORM 6

Participant Code:______________ Participant ID:______________ Age:____________

Date:________________________ Assessors:__________________

Early Echoic Skills Assessment (EESA)

Barbara E. Esch, Ph.D., BCBA, CCC-SLP

Scoring Groups 1-3: For each item, score the best response of up to 3 trials

X = correct sounds and correct number of syllables (1 point)
/ = recognizable response, but incorrect or missing consonants or extra syllables (½ point)
Blank = no response, incorrect vowels, or missing syllables (0 points)

TOTAL RAW SCORE: *(Groups 1-5)*

ASSESSMENT			
1st	2nd	3rd	4th

Group 1: Simple and reduplicated syllables

Targets: vowels, diphthongs, consonants p, b, m, n, h, w

Probe: t

- [/] ah
- [ ] wow
- [ ] bee
- [ ] knee
- [X] oo
- [X] bye bye
- [ ] hop
- [X] mama
- [X] papa
- [ ] me
- [X] one
- [ ] my
- [X] boo
- [ ] no no
- [ ] oh
- [ ] moo
- [X] up
- [ ] may
- [ ] pop
- [ ] too
- [ ] we
- [ ] boy
- [X] wa wa
- [X] toy
- [X] baa

Sub-total Group 1

1st	2nd	3rd	4th

Group 2: 2-syllable combinations

Targets: Add consonants k, g, t, d, f, y, ng

- [X] baby
- [ ] go eat
- [ ] nighttime
- [ ] bunny
- [ ] my foot
- [ ] yucky
- [ ] window
- [ ] funny
- [X] meow
- [ ] kitty
- [ ] bow wow
- [X] mommy
- [X] open
- [ ] oh boy
- [ ] yumm-o
- [X] potty
- [ ] pay day
- [ ] pokey
- [ ] taco
- [ ] foo-ey
- [ ] hankie
- [ ] too bad
- [X] cookie
- [ ] puppy
- [ ] icky
- [ ] too hot
- [ ] monkey
- [ ] uh-oh
- [ ] daddy
- [ ] hot dog

Sub-total Group 2

1st	2nd	3rd	4th

Group 3: 3-syllable combinations

- [ ] tubby toy
- [X] banana
- [ ] fee fi foe
- [ ] yummy food
- [ ] daddy up
- [ ] in a boat
- [ ] potato
- [ ] go bye bye
- [ ] fat doggy
- [ ] goofy goat
- [ ] hey me too
- [ ] my big toe
- [ ] do high five
- [ ] oh foo-ey
- [ ] binky boo
- [ ] one cookie
- [ ] open up
- [ ] peanut hat
- [ ] tiny pan
- [ ] peek a boo
- [ ] teddy bear
- [ ] doggy bone
- [ ] funny king
- [ ] a hiccup
- [ ] how many
- [ ] potty time
- [ ] giddy-up
- [ ] wet mitten
- [ ] teepee boat
- [ ] puppet game

Sub-total Group 3

1st	2nd	3rd	4th

Group 4: Prosody: spoken phrases (Model: Emphasize syllables in ***bold italics***)

X = emphasis on correct syllables (1 point)
/ = emphasis on non-target syllables (½ point)
Blank = monotone response (no emphasis) (0 points)

- [ ] no ***WAY***
- [ ] bug-a-***BOO***
- [ ] ***ONE*** bunny
- [ ] ***UH*** -oh
- [ ] in a ***MIN*** -ute
- [ ] ***MY*** mommy
- [ ] ***TAKE*** it
- [ ] bow-***WOW***
- [ ] my ***MOM*** -my
- [ ] ***BUG*** -a-boo

Sub-total Group 4

ASSESSMENT			
1st	2nd	3rd	4th

Group 5: Prosody: other contexts

X = response correct or nearly so (1 point)
Blank = response does not closely match model (0 points)

Pitch

- [ ] Echoes pitch variations in 1-2 lines of a familiar song
- [ ] Echoes continuous warble (fire truck *OO-oo-OO-oo-OO*)

Loudness

- [ ] Echoes whispering
- [ ] Echoes quiet/loud voice (*bye-bye* vs. **BYE-BYE**)

Duration

- [ ] Sustains *ahh* for 3 seconds, echoically

Sub-total Group 5

ASSESSMENT			
1st	2nd	3rd	4th

Baseline Vocalization Research Data Sheet:

Child Name :	Date:
Trainer Name :	Center:
Supervisor:	

Preferred Item or Activity (PIA)

1 – PIA List	2 – PIA List	3 – PIA List

VOCAL MANDS

Write the emitted Vocal / Approximations /	
Item Name	Vocal emitted
1. 2. 3. 4. 5. 6.	

VOCAL TACT Mark Response as ☑ ☒

Vocal Tact: (Present 2 preferred items as identified above) SD: What is this					
	1	2	3	4	5
Item 1:					
Item 2					

ECHOICS Mark Response as ☑ ☒

SD: Say _______					
	aa	o	Bu (as in but)	eee	Mmmm
Presentation 1					
Presentation 2					

INTRAVERBAL FILL-INS Mark Response as ☑ ☒

SD 1. 1,2 _____ SD 2: Ready Steady _____ SD3: Cow says ______ SD4: Sheep says _____				SD5: Twinkle Twinkle Little ______(star) SD6: Old Mc Donald..........(o) SD7: Johnny Johnny yes.........(ha ha ha) (Sing the rhyme, pause on last word)			
	SD1	SD2	SD3	SD4	SD5	SD6	SD7
Presentation 1							

Mand Training - Therapist Evaluation Pre-Intervention Form
Part 1: Oral Checklist

Therapist name :_______________ **Assessed by: ___________________________Date :________________**

Supervisor scores appropriate box for each item. Part 1 of checklist is administered by direct questioning in therapists native language

CRITERIA FOR PASSING: 100% CORRECT SUPERVISOR RE-ADMINISTERS CHECKLIST IF BELOW 100%

	Score +/-
1. Describes Mand as an operant	
Mand occurs under the control of motivating operations and the behavior of manding (requesting) is reinforced by the specific item or activity for which motivation exists	
2. Describes why Mand training is important in communication training	
Mand is one of the first forms of communication to emerge even in typically developing children Mand teaches child to behave as a speaker and directly rewards	
3. Describes the protocol for sign mand training with prompts and paired vocals	
Lists the steps – contrive motivation, ascertain interest, prompt sign (if not spontaneous), say name of item or activity, pause 2 seconds give item or activity and say name again, pause 2 seconds and say name of item	
PERCENT CORRECT	

Part 2: Performance Checklist

Instructions:
Supervisor administers Part 2 of the checklist by watching role-plays and observing the specified behaviors during the lesson. For each item involved in the observation, the supervisor scores a (+) if the behavior is implemented correctly, a (-) if the behavior is implemented incorrectly, and N/A if it is not necessary or applicable to perform the behavior.

	Score first 10 trials									
Implements Mand Training protocol	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**
a) Does a brief preference assessment to decide target and contrives motivation for target item										
b) Ascertain there is MO – reach out/ look at										
c) prompt sign (if not spontaneous) and pair vocal stimulus										
d) 2 second pause between three vocal stimuli presentations										
e) Delivery of specific reinforcement within 1 second of sign completion(prompted or independent)										
Totals										
PERCENT CORRECT	_______%									

CRITERIA FOR PASSING: 90% CORRECT SUPERVISOR RETRAINS and RE-ADMINISTERS CHECKLIST IF BELOW 90%

FORM 8.2

Therapist evaluation before Intervention for Delayed Vocal Prompt
Part 1: Oral Checklist

Therapist name :_______________ Assessed by: ___________________________Date :________________

Supervisor scores appropriate box for each item. Part 1 of checklist is administered by direct questioning in therapists native language

	Score +/-
1. Describes why Time Delay can help and when it should not be used	
Time delay procedures are evidence based and provide more opportunities to reinforce sponatenous responding. They cannot be used if there are signs of distress in the delay period or if the participant exhibits impulsivity or aggression	
2. Describes the protocol for Delayed Prompts	
Lists the steps – contrive motivation, ascertain interest, prompt sign within 2 seconds (if not spontaneous), pause 5 seconds , reinforce if child emits a vocal that is whole or part of target word. If there is no vocal at the end of 5 seconds, say the target word, pause 2 seconds, say the target word again, pause 2 more seconds, deliver the specific item or activity and say the name.	
PERCENT CORRECT	

CRITERIA FOR PASSING: 100% CORRECT SUPERVISOR RE-ADMINISTERS CHECKLIST IF BELOW 100%

Part 2: Performance Checklist

Instructions:

Supervisor administers Part 2 of the checklist by watching role-plays and observing the specified behaviors during the lesson. For each item involved in the observation, the supervisor scores a (+) if the behavior is implemented correctly, a (-) if the behavior is implemented incorrectly, and N/A if it is not necessary or applicable to perform the behavior.

	Score first 10 trials									
Implements time delay procedure by:	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**
a) Do a brief preference assessment, contrive motivation specific to mand target, Ascertain reachout										
b) prompt sign (if not spontaneous)										
c) 5 second delay and reinforce if participant emits spontaneous vocal during the delay period										
d) Present Vocal at end of 5 seconds and additional 2 times with 2 second gap each if required										
e) Delivery of specific reinforcement after a vocal response or at the end of 'd'										
Totals										
PERCENT CORRECT	_______%									

CRITERIA FOR PASSING: 90% CORRECT SUPERVISOR RETRAINS and RE-ADMINISTERS CHECKLIST IF BELOW 90%

FORM 8.3

Therapist evaluation before Intervention for Intraverbal training
Part 1: Oral Checklist

Therapist name :_______________ Assessed by: __________________________Date :________________

Supervisor scores appropriate box for each item. Part 1 of checklist is administered by direct questioning in therapists native language

	Score +/-
1. Describes Intraverbal as an operant	
Intraverbal response occurs when the antecedent is a verbal stimulus, response does not resemble the prior verbal stimulus and a reinforcing consequence follows.	
2. Describes why Intraverbal is important in communication training	
It promotes listener and speaker behaviors simultaneously and will be necessary for providing personal information or building peer relationships	
3. Describes the protocol for Intraverbal training:	
Lists the steps – Do a brief assessment to identify reinforcer, present antecedent verbal stimulus unit as prescribed, pause for 2 seconds , if there is a response that is part of all of the target response then reinforce otherwise say the target vocal once and move on to break or next trial	
PERCENT CORRECT	

CRITERIA FOR PASSING: 100% CORRECT SUPERVISOR RE-ADMINISTERS CHECKLIST IF BELOW 100%

Part 2: Performance Checklist

Instructions:
Supervisor administers Part 2 of the checklist by watching role-plays and observing the specified behaviors during the lesson. For each item involved in the observation, the supervisor scores a (+) if the behavior is implemented correctly, a (-) if the behavior is implemented incorrectly, and N/A if it is not necessary or applicable to perform the behavior.

	Score first 10 trials									
Implements Intraverbal fill in training procedure	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**
a) Does a brief preference assessment and decides reinforcer to be delivered										
b) Presents antecedent verbal stimulus unit as per target										
c) ensures build up in rhyme singing or appropriate intonation in other fill ins while presenting antecedent verbal stimulus unit										
d) Pauses 2 seconds										
e) Reinforces correct response (part or whole word) or says the target vocal once and moves on to next trial										
Totals										
PERCENT CORRECT	_______%									

CRITERIA FOR PASSING: 90% CORRECT SUPERVISOR RETRAINS and RE-ADMINISTERS CHECKLIST IF BELOW 90%

PREFERENCE ASSESSMENT DATA SHEET - FREE OPERANT

Time: Partial Interval Recording- Engagement in activities

Student: Date: Observer:

Codes: See-Saw= E Swing= W Slide= L

Merry-go-round= M Sand= A Trampoline= L

Sample Filled

Seconds	**0-10**	**20**	**30**	**40**	**50**	**60**
Minute 1						
Min 2						
Min 3						
Min 4						
Min 5						

Observation 1

Seconds	**0-10**	**20**	**30**	**40**	**50**	**60**
Minute 1						
Min 2						
Min 3						
Min 4						
Min 5						

Observation 2

Seconds	**0-10**	**20**	**30**	**40**	**50**	**60**
Minute 1						
Min 2						
Min 3						
Min 4						
Min 5						

Observation 3

Seconds	**0-10**	**20**	**30**	**40**	**50**	**60**
Minute 1						
Min 2						
Min 3						
Min 4						
Min 5						

	E	M	W	A	L	T
# Intervals						
%						
Rank						

FORM 10

Multiple-Stimulus Without Replacement Preference Assessment Data Sheet

Participant code: ___________________ UID ___________ Assessor : ____________________

Center : ____________________

Stimuli

1.	2.	3.	4.
5.	6.	7.	

Present 6-7 items; Write item selected first against trial ‘1’ in item selected column. Remove item from array, present remaining items. Write in item selected column against trial 2. Repeat until all items are selected or when child selects none of remaining items. Repeat assessment over 4 sessions

Session 1 **Initial Order: 1-2-3-4-5-6-7**	**Date:**
Circle item position	**Item Selected**
Trial 1. 1 2 3 4 5 6 7	
Trial 2. x x x x x x	
Trial 3. x x x x x	
Trial 4. x x x x	
Trial 5. x x x	
Trial 6. x x	
Trial 7. x	

Session 3 **Initial Order: 5-6-7-1-2-3-4**	**Date:**
Circle item position	**Item Selected**
Trial 1. 1 2 3 4 5 6 7	
Trial 2. x x x x x x	
Trial 3. x x x x x	
Trial 4. x x x x	
Trial 5. x x x	
Trial 6. x x	
Trial 7. x	

Session 2 **Initial Order: 3-4-5-6-7-1-2**	**Date:**
Circle item position	**Item Selected**
Trial 1. 1 2 3 4 5 6 7	
Trial 2. x x x x x x	
Trial 3. x x x x x	
Trial 4. x x x x	
Trial 5. x x x	
Trial 6. x x	
Trial 7. x	

Session 4 **Initial Order: 7-1-2-3-4-5-6**	**Date:**
Circle item position	**Item Selected**
Trial 1. 1 2 3 4 5 6 7	
Trial 2. x x x x x x	
Trial 3. x x x x x	
Trial 4. x x x x	
Trial 5. x x x	
Trial 6. x x	
Trial 7. x	

Sl	Name of item	No. of times selected							Final Rank
		1	2	3	4	5	6	7	
1									
2									
3									
4									
5									
6									
7									

Manual Sign Mand Training with Paired Vocals - Treatment Integrity form
Week 1 - 100 trials check

Participant Code: _______ UID: _________ Assessment dates : From ______ to ______

Therapist: __________ Supervisor : __________

Instructions for filling:

For each trial mark a tick against each compoment if therapist implements correctl
If child emits sign spontaneously mark correct in PS if therapist proceeds with next ste
If child emits part of vocal spontaneously, therapist to deliver reinforcement immediatel
Enter total score in last column at end of sessior ***If less than 80% in any set of 10 consecutive trials, stop TI check and retrai***

Codes in form

CM- Contrive Motivation and Ascertain Interest **PS-** Prompts the sign **PV-** Pairs vocal

V2SG- 2 sec gap between each vocal **DR-** Delivers Reinforcer

Trial	CM	PS	PV	V2SG	DR	Total	Trial	CM	PS	PV	V2SG	DR	Total	Trial	CM	PS	PV	V2SG	DR	Total
1							35							69						
2							36							70						
3							37							71						
4							38							72						
5							39							73						
6							40							74						
7							41							75						
8							42							76						
9							43							77						
10							44							78						
11							45							79						
12							46							80						
13							47							81						
14							48							82						
15							49							83						
16							50							84						
17							51							85						
18							52							86						
19							53							87						
20							54							88						
21							55							89						
22							56							90						
23							57							91						
24							58							92						
25							59							93						
26							60							94						
27							61							95						
28							62							96						
29							63							97						
30							64							98						
31							65							99						
32							66							100						
33							67							101						
34							68							102						

Total score from 100 Trials Max possible score = 500 % Ti _____%

Therapist Sign: Supervisor Sign :

FORM 11.1 B

Manual Sign Mand Training with Paired Vocals - Treatment Integrity form:

Month 2 onwards – one trial per target per month

Participant code: UID: Assessor initials:

Instructions for Filling

- For each trial mark a tick against each component if therapist implements correctly
- If child emits sign spontaneously mark correct in PS if therapist proceeds with next step
- If child emits part of Vocal spontaneously, mark PV as correct if therapist delivers reinforcement immediately
- Enter total score in last column at end of session; If %TI less than 80%, retrain and re do theTI check

Codes in form

CM- Contrive Motivation and Ascertain **PS** Prompts the sign if required **PV-** Pairs vocal
V2SG- 2 sec gap between each vocal **DR-** Delivers Reinforcer

Date : Therapist : Supervisor :

Sl no	Mand Target	CM	PS	PV	V2SG	DR
1						
2						
3						
4						
5						
6						

Total Score	
% TI	

Date : Therapist : Supervisor :

Sl no	Mand Target	CM	PS	PV	V2SG	DR
1						
2						
3						
4						
5						
6						

Total Score	
% TI	

FORM 11.2 A

Delayed Vocal Prompt - Treatment Integrity form
Week 1 - 100 trials check

Participant Code: _______ UID: _________ Assessment dates : From ______ to ______

Therapist: __________ Supervisor : __________

Instructions for filling:

For each trial mark a tick against each compoment if therapist implements correctly
If child emits sign spontaneously mark correct in PS if therapist proceeds with next step
If child emits part of Vocal spontaneously, therapist to deliver reinforcement immediately
Enter total score in last column at end of session ***If less than 80% in any set of 10 consecutive trials, stop TI check and retrain***

Codes in form

CM- Contrive Motivation and Ascertain Interest **PS-** Prompts the sign if required **5 Sdel- 5 sec** delay

PV- a) unprompted vocal/ Vocal after prompt - deliver reinforcer and pair word as per protocol.

DR- Delivers Reinforcer as per protocol

Trial	CM	PS	5 Sdel	PV	DR	Total	Trial	CM	PS	5 Sdel	PV	DR	Total	Trial	CM	PS	5 Sde	PV	DR	Total
1							35							69						
2							36							70						
3							37							71						
4							38							72						
5							39							73						
6							40							74						
7							41							75						
8							42							76						
9							43							77						
10							44							78						
11							45							79						
12							46							80						
13							47							81						
14							48							82						
15							49							83						
16							50							84						
17							51							85						
18							52							86						
19							53							87						
20							54							88						
21							55							89						
22							56							90						
23							57							91						
24							58							92						
25							59							93						
26							60							94						
27							61							95						
28							62							96						
29							63							97						
30							64							98						
31							65							99						
32							66							100						
33							67							101						
34							68							102						

Total score from 100 Trials Max possible score = 500 % Ti _____%

Therapist Sign: Supervisor Sign :

FORM 11.2 B

Manual Sign Mand Training with Delayed Vocal Prompt - Treatment Integrity form:

Month 2 onwards – one trial per target per month

Participant code: UID: Assessor initials:

Instructions for Filling

- *For each trial mark a tick against each component if therapist implements correctly*
- *If child emits sign spontaneously mark correct in PS if therapist proceeds with next step*
- *If child emits part of Vocal spontaneously, therapist to deliver reinforcement immediately*
- *Enter total score in last column at end of session*

Codes in form

CM- Contrive Motivation and Ascertain **PS** Prompts the sign if required **5Del – 5 Second Delay**

PV - a) unprompted vocal/ Vocal after prompt - deliver reinforcer and pair word as per protocol. b) No Vocal - Pair word with delivery of reinforcer 2 times with a gap of 2 secs each
DR- Delivers Reinforcer as per protocol

Date : Therapist : Supervisor :

Sl no	Mand Target	CM	PS	5Del	PV	DR
1						
2						
3						
4						
5						
6						

Total Score	
% TI	

Date : Therapist : Supervisor :

Sl no	Mand Target	CM	PS	5Del	PV	DR
1						
2						
3						
4						
5						
6						

Total Score	
% TI	

FORM 11.3 A

Intraverbal Fill in Training - Treatment Integrity form
Week 1 - 100 trials check

Participant Code: _______ UID: _________ Assessment dates : From ______ to ______

Therapist: __________ Supervisor : __________

Instructions for filling:

For each trial mark a tick against each compoment if therapist implements correctl
If child emits part of Vocal spontaneously, therapist to deliver reinforcement immediatel
Enter total score in last column at end of sessior ***If less than 80% in any set of 10 consecutive trials, stop TI check and retrair***

Codes in form

PA - Conducts brief pref. assessment **AVS - Presents Antecedent Verbal Stimulus** **BU -** Ensures build up
Csq - Delivers reinforcer if specific vocal is emitted or provides a brief break and moves on **2SP -** 2 sec pause

Trial	PA	AVS	BU	2SP	CSQ	Total	Trial	PA	AVS	BU	2SP	CSQ	Total	Trial	PA	AVS	BU	2SP	CSQ	Total
1							35							69						
2							36							70						
3							37							71						
4							38							72						
5							39							73						
6							40							74						
7							41							75						
8							42							76						
9							43							77						
10							44							78						
11							45							79						
12							46							80						
13							47							81						
14							48							82						
15							49							83						
16							50							84						
17							51							85						
18							52							86						
19							53							87						
20							54							88						
21							55							89						
22							56							90						
23							57							91						
24							58							92						
25							59							93						
26							60							94						
27							61							95						
28							62							96						
29							63							97						
30							64							98						
31							65							99						
32							66							100						
33							67							101						
34							68							102						

Total score from 100 Trials Max possible score = 500 % Ti _____%

Therapist Sign: Supervisor Sign :

Intraverbal Training - Treatment Integrity form:

Month 2 onwards – one trial per target per month

Participant code: UID: Assessor initials:

Instructions for Filling

- For each trial mark a tick against each component if therapist implements correctly
- If child emits part of Vocal spontaneously, deliver reinforcer immediately
- Build up –If it is a rhyme initial part needs to be sung with voice trailing off for fill in, for contextual, animal sounds – voice should trail off after presenting antecedent vocal stimulus unit
- Enter total score in last column at end of session; If %TI less than 80%, retrain and re do the TI check

Codes in form

PA – Conducts brief Pref Assessment **AVS -** Presents Antecedent Verbal Stimulus

BU - Ensures build up **2SP -** 2 sec pause

CSQ - Delivers reinforcer if specific vocal is emitted or provides a brief break and moves on

Date : Therapist : Supervisor :

Sl no	IV Target	PA	AVS	BU	2SP	CSQ
1						
2						
3						
4						
5						
6						

Total Score	
% TI	

Date : Therapist : Supervisor :

Sl no	IV Target	PA	AVS	BU	2SP	CSQ
1						
2						
3						
4						
5						
6						

Total Score	
% TI	

FORM 12

Post Vocalization Acquisition Probe Data Sheet:

Child Name :	Date:
Trainer Name :	Center:
Supervisor:	

Preferred Item or Activity (PIA)

1 – PIA List	2 – PIA List	3 – PIA List

VOCAL MANDS

Vocal Mands:
- 3 Observations of 30 minutes after Reinforcer Assessment.
- Reinforcers to remain in view
- Trainer to block reinforcer access by 10 seconds to observe vocalization

Write the emitted Vocal / Approximations /

Item Name	Vocal emitted

The following needs to be assessed as per guidelines in the methodology

VOCAL TACT Mark Response as ☑ ☒

Vocal Tact: (Present 2 preferred items as identified above)
SD: What is this

	1	2	3	4	5
Item 1:					
Item 2					

ECHOICS Mark Response as ☑ ☒

SD: Say _______

	aa	o	Bu (as in but)	eee	Mmmm
Presentation 1					
Presentation 2					

INTRAVERBAL FILL-INS Mark Response as ☑ ☒

SD 1. 1,2 _____
SD 2: Ready Steady _____
SD3: Cow says ______
SD4: Sheep says _____
SD5: Twinkle Twinkle Little ______(star)
SD6: Old Mc Donald………..(o)
SD7: Johnny Johnny yes………(ha ha ha)
(Sing the rhyme, pause on last word)

	SD1	SD2	SD3	SD4	SD5	SD6	SD7
Presentation 1							
Presentation 2							

FORM 13

SKILL TRACKING SHEET

Name Of Learner: ________________________________ Skill: ____________________________

Receptive / Tact / Intraverbal

Procedure:

SD1: SD: 3

SD2: SD: 4

ABLLS	Target	Intro	Ach	Days to mastery

Smita Awasthi, BCBA

FORM 14

MAND DATA FORM

Date	No of Mands Unprompted	Prompted	Person	Total

PROBE DATA SHEET - ACQUISITION TARGETS **FORM 15**

Name of Child:	**Reinforcement Schedule:**
Achievement Criteria: 2Y 3Y 5Y 7Y	**Prompt Type:**

TARGETS DATE																		Date Intro	Date Ach
INITIALS																			
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		
	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N		

REINFORCEMENT ASSESSMENT CHECKLIST

Name of Student: **Date:**

Instruction: Place 4 items on table. Allow student to select any. Put a tick for selected item. Repeat the same for 3 day

Month		Initials													
SI NO	**Category**	**Date**						**SI NO**	**Category**	**Date**					
1	Visual	Lights Toy						41	Kinesthetic	Trampoline					
2		Spin Toys						42		Slide					
3		Rainmaker						43		Swing					
4		Top						44		Merry go round					
5		Bubbles						45		Bouncing Ball					
6		Spring						46		Scooter					
7		Kaleidoscope						47		Swinging Ladder					
8		Binoculars						48		Tickle					
9		Matching						49		Massage					
10		Lotto game						50		Spinning chair / air					
11		Pouring Sand						51		Rocking horse					
12		DVD						52		Throw in air					
13		Mobile Visuals						53	Edible	Candy/Lollipop					
14		Books						54	Sweet	Chocolate/Gems					
15		Computer						55		Biscuit					
16	Tactile	Playdoh						56		Indian Sweets					
17		Slime						57		Raisins					
18		Squeezy ball						58		Fruits					
19		Soft toys						59	Salt	Waffers					
20		Rubber toys						60		Chips/Papad					
21		Sand						61		Kurkure					
22		Bean bags						62		Muruku					
23		Grains						63		Fryums/Gold Finger					
24	Audio	Music System						64	Drink	Juice					
25		Musical Toys						65		Water					
26		Music on mobile						66		Nimbu Pani					
27		Singing						67		Milk Shakes					
28		Drums						68	S-R Toys	Puzzles					
29		Cymbals						69		Jack in the box					
30		Piano						70		Magnet					
31		Xylophone						71		Robot toys					
32		Mouth Organ						72		Pen/Pencil					
33		Flute						73		Paint/Crayon					
34		Trumpet						74		Paper Sticking					
OTHER REINFORCERS															

Appendix 2

Tables

TABLE 12

Summary All Participant

S.No	MBL	Code	Age at intake Yr.Mth	Gender	Diagnosis	Loc	Baseline Vocal Status	Inclusion Status	Expt. No	Final Vocal Status	Days to FV	Days to 7v	V1	V2	V3	V4	V5	V6	V7	EM	M	IV	Ech
1	**1**	Biso	3	M	ASD	B	NV	Yes	1	V	8	24	moo-music	pas- puzzle	toe- toy	jum- jump	bu-bu(bubbles)	poo(push)	wee-(swing)	0	7	0	0
2	**1**	LIV	2.9	M	ASD	M	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
3	**1**	Amaz	2.8	M	ASD	M	NV	Yes	1	V	12	29	ball	music	side (slide)	bicuit(buiscuit)	toy	book	banana	0	7	0	0
4	**1**	Digun	4	M	ASD	B	NV	Yes	1	V	39	113	Ba (buiscuit)	Mu- music	Mee (echoic)	Bo (book)	Pu(puzzle)	Ta(toy)	Ju(jump)	6	0	0	1
5	**1**	Dako	13.5	M	ASD	M	NV	Yes	1	V	16	152	chee(chips)	paee(pani)	swing(see)	Jucie(Jun)	Book(Boo)	Move(Movo)	Open(op)	7	0	0	0
6	**1.ss**	NPR	5.6	F	ASD	B	NV	Yes	1	V	31	39	pit (sand pit)	icercam	Swing	up(on see saw)	Push	shoe	Sit	4	3	0	0
7	**1.ss**	RKA	5.6	F	ASD	B	NV	Yes	1	V	48	161	Car	Apple - Apu	Apple	Ca - Car	Ba Ba - bubble	moo-moo	bow-bow	4	0	2	1
8	**1.2**	SAJ	8	M	ASD	B	NV	Yes	1	V	28	270	Mm (music)	Pa (push)	Ba (bubbles)	Cha (chip)	Sss (swing)	Eeia-oh	Papa	5	0	2	0
9	**1.2**	RRA	2.4	M	ASD	B	NV	Yes	1	V	44	82	mmm(music)	ya ya	chocho	wi (swing)	See (sing)	huay (hurray)	Cu (come)	0	5	2	0
10	**1.2**	RJO	4.6	F	ASD	D	NV	Yes	1	V	11	69	aa (aao)	O (opa)	e (eat)	koo koo(kurkure)	Ka (car)	Ba (biscuit)	mmm (music)	6	1	0	0
11	**1.2**	ASIN	4.8	F	ASD	N	NV	Yes	1	V	22	64	ee (chips)	go	huae (hurray)	oo (out)	aao	ju jump	pu-pu (bubble)	5	2	0	0
12	**1.2**	ANA	2.5	M	ASD	B	NV	Yes	1	V	87	133	Music	Swing	Water	S (echoic)	move	Down (Roly poly)	Baba (Bubbles)	1	4	1	1
13	**1.2**	DSA	2.10	M	ASD	B	NV	Yes	1	V	19	144	Toy	Push	music	chips	MGR	swing	sit	0	7	0	0
14	**1.3**	AGU	1.5	M	ASD	B	NV	Yes	1	V	46	46	BA (bubbles)	DA (down)	FA (blow)	HA	JA (jump)	MA (music)	LA (light)	6	0	0	1
15	**1.3**	KRD	2.1	M	ASD	B	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
16	**1.3**	ASING	1.7	M	ASD	B	NV	Yes	1	V	117	271	See	Jump	Open	Hold	Aa (Come)	E	I	1	4	0	2
17	**1.3**	ABAD	3.9	M	ASD	M	NV	Yes	1	V	28	165	ba ba (bubbles)	go	Bubbles	campiter	car	sing	toila (toilet)	0	7	0	0
18	**1.3**	HDE	9.6	M	ASD	M	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
19	**1.3**	RSA	2.11	M	ASD	M	NV	Yes	1	V	27	68	oo (out)	jump	dance	biscuits	water	aa	ee	2	3	0	2
20	**1.4**	CTI	6.1	M	ASD	D	NV	Yes	1	V	71	227	Pata (paratha)	Aaa (aao=come)	Tu (toy)	eee (chips)	Ooo (echoic)	puta (computer)	Va (water)	4	2	0	1
21	**1.4**	SMI	3.10	M	ASD	N	NV	Yes	1	V	274	316	Aaa	Go	Oooo (Out)	Yes papa	Eee	Ba ba (bubbles)	Up	5	0	1	1
22	**1.4**	KSH	1.4	M	ASD	M	NV	Yes	1	V	116	133	toy	car	oken (open)	Sheep says	aa (up)	three	go(ready steady)	1	3	3	0
23	**1.5**	NNA	3.2	M	ASD	B	NV	Yes	1	V	46	72	Paa (Push)	Ba (bubble)	doh(play doh)	come	Coo	pi	Book	3	2	0	2
24	**1.5**	AUA	2.6	M	ASD	B	NV	Yes	1	V	241	385	ja-jump	ta - toy	da-roly poly	up	ba-baloon	out -roly poly	Yes	0	5	2	0
25	**1.5**	SMA	5.10	M	ASD	B	NV	Yes	1	V	174	378	a Toy)	ja-juice	wa-water	baba-bubble	Go (em)	oo (echoic)	ee-echoic	5	0	0	2
26	**1.5**	AMO	4.4	F	ASD	M	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
27	**1.6**	PSE	5.11	M	ASD	B	NV	Yes	1	V	72	254	Go	Kae (cake)	toy	La (echo)	Ju (jump)	Wateh (water)	Moo (move)	2	4	0	1
28	**1.6**	IPA	4.2	M	ASD	B	NV	Yes	1	V	15	67	Crayon	Come	baloon	spin	jump	push	music	0	7	0	0
29	**1.6**	VPRI	5.7	M	ASD	B	NV	Yes	1	V	299	644	Op - Open	Bo Ball	Hi	Baba - bubble	Go	Moo (Move)	Ki (key)	4	2	0	1
30	**1.7**	SPR	4.6	M	ASD	B	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
31	**1.7**	PGO	2.9	F	ASD	D	NV	Yes	1	V	51	104	Three (mand)	Ba (bubble)	Bed (sleep)	Down	roses (ring a)	Pop	Aaao	0	6	1	0
32	**1.7**	PNA	2.11	M	ASD	B	NV	Yes	1	V	5	23	music	toy	jump	flower	computer	jeep	tickle me	0	7	0	0
33	**1.8**	RPA	2.9	M	ASD	B	NV	Yes	1	V	7	32	music	toy	chips	come	spin	book	push	0	7	0	0
34	**1.8**	SVER	5.8	M	ASD	N	NV	Yes	1	V	81	259	Up	aa (aao)	O (Open)	Open	Jump	Come	Go	2	5	0	0
35	**1.8**	AKU	2.5	M	ASD	D	NV	Yes	1	V	23	207	Ba (bubble)	Go	Da (Down)	Ka (Computer)	Down	Push	Toff	0	6	1	0
36	**1.8**	RDA	3.4	M	ASD	D	NV	Yes	1	V	706	778	Cu (computer)	mu (music)	ju (jump)	go	ha-ha	tu (toilet)	aa (echoic)	5	0	1	1
37	**1.9**	ACH	4.1	M	ASD	D	NV	Yes	1	V	27	273	Ba (bubble)	toffee	You	Well (Pussy in the)	Bell	Pen	Moo (move)	1	4	2	0
38	**1.9**	PPA	2.11	M	ASD	B	NV	Yes	1	V	69	135	Music	Toy	Water	Jump	Computer	Chips	Open	0	7	0	0
39	**1.9**	ASH	3.9	M	ASD	D	NV	Yes	1	V	49	237	bubu (bubble)	cu (car)	poo (push)	pa (pani)	bow bow	go (ready steady)	O (open)	2	3	2	0
40	**1.9**	DSO	2.7	M	ASD	B	NV	Yes	1	V	51	120	Slide	Toy	Push	Move	Out	water	Blow bubbles	0	7	0	0
41	**1.10**	SSE	3.8	M	ASD	D	NV	Yes	1	V	18	220	Chips	Open	Push	three (EM)	lane	down - mand	bed (jumping on)	0	4	0	3

S.No	MBL	Code	Age at intake Yr.Mth	Gender	Diagnosis	Loc	Baseline Vocal Status	Inclusion Status	Expt. No	Final Vocal Status	Days to FV	Days to 7v	V1	V2	V3	V4	V5	V6	V7	EM	M	IV	Ech
42	**1.10**	USE	2.7	F	ASD	N	NV	Yes	1	V	13	32	water	jump	slime	susu	swing	come	play doh	0	7	0	0
43	**1.10**	SRA	4.7	M	ASD	M	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
44	**1.11**	AJOS	6.2	M	ASD	M	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
45	**1.11**	SMO	3	F	ASD	B	NV	Yes	1	V	91	133	sand	out	swing	slide	see	chips	move	0	7	0	0
46	**1.11**	MSH	5.8	M	ASD	N	NV	Yes	1	V	16	292	tu - toy	ca - car	pu - push	Aa (wonder...are)	pa (push)	ha (johnny)	bu (bubble)	5	0	2	0
47	**1.11**	ARE	6.7	M	ASD	M	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
48	**1.11**	SVEE	4.2	M	ASD	H	NV	Yes	1	V	220	229	aa - (come)	ma (music)	opea - open	caeee (carry)	3	outu	moosika	2	4	1	0
49	**1.12**	SRE	5.2	M	ASD	B	NV	Yes	1	V	75	76	toy	book	open	sit	crayon	move	puzzle	0	7	0	0
50	**1.12**	VKI	3.1	F	ASD	H	NV	Yes	1	V	33	33	ee (chips)	u	o	oo	ba	da	ja	1	0	0	6
51	**1.12**	ZMO	2.9	F	ASD	H	NV	Yes	1	V	13	28	open	computer	sit	out	carry	music	spin	0	7	0	0
52	**1.12**	PKA	4.6	M	ASD	M	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
53	**1.12**	SAM	5.2	M	ASD	H	NV	Yes	1	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
54	**1.12**	AQU	4.2	M	ASD	H	NV	Yes	1	V	42	44	toy - to	bab- bubble	buiss- buiscut	opu- open	aaoo- out	tata- water	pash - push	0	7	0	0
55	**1.13**	SSRU	2.11	M	ASD	B	NV	Yes	1	V	48	125	Music	MGR	Move	Swing	Toy	Come	teddy(around)	0	6	1	0
56	**1.13**	PKE	9.3	M	ASD	H	NV	Yes	1	V	10	58	food	jump	toy	bu-bu-bubbles	leave	push	out	4	3	0	0
57	**1.13**	MAR	3.4	M	ASD	H	NV	Yes	1	V	282	292	ba b (bubble)	"aa" (go)	carry	toy	music	chips	buiscuit	3	4	0	0
58	**1.13**	AAK	3	M	ASD	H	NV	Yes	1	V	176	225	tata (toy)	baba (bubbles)	cooka (kurkure)	piano	music	push	out	3	4	0	0
59	**2.1**	Ashar	5	M	ASD	B	NV	Yes	2	V	5	30	biss -biscuit	Pus -push	Mu-music	tu-toy	chee-chips	Ba-baloon	sss(slide)	0	7	0	0
60	**2.1**	Hipal	5.10	M	ASD	B	NV	Yes	2	V	43	63	mo (move)	ow(out)	su(show)	Boh(ball)	bu(biscuit)	mu(music)	ss(swing)	0	7	0	0
61	**2.1**	Akon	4.1	M	ASD	B	NV	Yes	2	V	23	44	tu-toy	fie(fries)	bunce(bounce)	spun (spoon)	o(old mc ….)	stah(twinkle)	papa(johnny)	0	4	3	0
62	**3**	Neha	3.5	F	ASD	N	NV	Yes	3	V	19	166	Ca (says meow)	Baa (sh says)	go(ready…)	Moo (cow says)	pu (push)	bow (dog says)	aao (come)	2	0	5	0
63	**3**	Barry	3.2	M	ASD	D	NV	Yes	3	V	49	77	go	O (eeya)	sta (star)	boo (boogie..)	Baa (sheep_)	Papa (johny)	thee (1,2..)	0	0	7	0
64	**3**	Reyan	1.10	M	ASD	D	NV	Yes	3	V	5	99	Ba ba	aa	Pa	oo	Cooa (quack)	Chuku	O (eeya..)	0	0	4	3
65	**3**	Mahar	3.4	M	ASD	D	NV	Yes	3	V	87	228	3	Ee (chips)	M (music)	Ba sheep says	Go	Oo (eeya eeya)	Pun (hot cross)	3	0	4	0
66	**3**	Ricky	2.11	M	ASD	B	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
67	**3.1**	AKA	4.11	M	ASD	D	NV	Yes	3	V	14	141	Aa (star)	O (eeya..)	Baa (sh says..)	Moo (cow says)	Pa (pus)	Daa (Down)	Meow	2	0	5	0
68	**3.1**	MTH	6.11	F	ASD	B	NV	Yes	3	V	65	120	Ba (biscuit)	Pa	Bu (bubble)	Ta	pu (pus)	Bo (ball)	Aa (Star)	4	0	1	2
69	**3.1**	SYE	3.11	M	ASD	B	NV	Yes	3	V	5	60	Aam (mango)	Aa (star)	Ba (sheep says)	O (eeya..)	Three (1,2..)	Hah (johny..)	Pop	2	0	5	0
70	**3.2**	MDU	3.4	F	ASD	N	NV	Yes	3	V	32	122	moo cow says	3	Baba - sheep	wee - slide goes	bw bow	hiss	Aa (wonder...are)	0	0	7	0
71	**3.2**	ASH	4.8	M	ASD	N	NV	Yes	3	V	49	237	Pi (puzzle)	Aaa (toy)	EE (echoic)	See (swing)	bu (bubbles)	PU (echoic)	O - eeya eeya	4	0	1	2
72	**3.2**	RPR	2.2	F	ASD	N	NV	Yes	3	V	119	220	ju (jump)	swing	music	Aa (come)	go	Bu-bu (bubble)	Eee (mc donald)	3	3	1	0
73	**3.2**	AJAV	2.8	M	ASD	M	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
74	**3.2**	SSR	3.4	M	ASD	B	NV	Yes	3	V	18	116	baa(sheep says)	ca (candy)	boo (book)	moo (move)	mujee (music)	pa (puzzle)	Three	4	1	2	0
75	**3.2**	YDH	4.2	M	ASD	M	NV	Yes	3	V	107	568	aa..aa (come)	mm (music)	bubu (bubble)	Toilet (toi)	Toy (ta)	pa..(push)	Bow bow	4	2	1	0
76	**3.3**	JSR	3.5	M	ASD	H	NV	Yes	3	V	24	24	aa (star)	ee	aai	oo	BA	do	hi	0	0	1	6
77	**3.3**	AMAD	3.4	M	ASD	B	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
78	**3.3**	SAV	2.6	M	ASD	H	NV	Yes	3	V	16	33	ss - spin	ou (out)	che (change)	wu - water	bau - ball	to - toy	cho - chocolate	0	7	0	0
79	**3.4**	Ann	12.2	F	ASD	B	NV	Yes	3	V	96	115	bb(bubble)	Wa (water)	No	O-pa (open)	Pi (Piano)	(tv)	U (cashew)	0	7	0	0
80	**3.4**	RHA	4.6	M	ASD	B	NV	Yes	3	V	254	258	Ca (car)	Pa (pus)	Ma(music)	Bu (bubble)	Bi (buiscuit)	Ci	Pi	5	0	0	2
81	**3.4**	SSA	4.9	M	ASD	D	NV	Yes	3	V	108	315	ba	Go (ready..)	Water	hurray	three	chuk	hands (wash your)	0	1	6	0

S.No	MBL	Code	Age at intake Yr.Mth	Gender	Diagnosis	Loc	Baseline Vocal Status	Inclusion Status	Expt. No	Final Vocal Status	Days to FV	Days to 7v	V1	V2	V3	V4	V5	V6	V7	EM	M	IV	Ech
82	**3.4**	ASUR	5.2	M	ASD	N	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
83	**3.4**	AJSI	4.3	M	ASD	M	NV	Yes	3	V	176	239	biscee (buiscuit)	chip	opu (open)	kooo (kurkure)	cur (car)	three	go	0	5	2	0
84	**3.4**	CMA	4.8	F	ASD	B	NV	Yes	3	V	173	250	Star	Go	Moo moo	3	Yes papa	Out	Aa (Star)	0	0	7	0
85	**3.4**	SVEN	4.9	M	ASD	H	NV	Yes	3	V	111	139	aa (come)	Hoo hurray	ba (echoic)	K (car)	ow(dog says)	mm (music)	ss (swing)	4	0	2	1
86	**3.4**	MCH	1.8	F	ASD	M	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
87	**3.5**	KBA	6	F	ASD	B	NV	Yes	3	V	52	176	meow	bo-bow	ne-ne	ba	ee-aw(hee haw)	cooack (quack)	hoot (owl)	0	0	7	0
88	**3.5**	APA	5.11	M	ASD	B	NV	Yes	3	V	203	461	aa (aao come)	Pa (pus)	mmm (music)	eee (chips)	Oo	ma (mango)	Baa (sheep)	5	0	1	1
89	**3.5**	AKUM	2.7	F	ASD	B	NV	Yes	3	V	113	113	wa-water	toy	yes papa	bow bow	nae-nae (neigh)	go(ready..)	I'm fine	2	0	5	0
90	**3.5**	NYGA	2	M	ASD	M	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
91	**3.6**	ASHE	4.9	M	ASD	B	NV	Yes	3	V	11	405	bu (bubbles)	sss (snake..)	Chee (chips)	O (open)	aa	ba (sheep)	go (ready…)	3	0	3	1
92	**3.6**	SMAT	6	M	ASD	N	NV	Yes	3	V	5	327	Aa aao	ba - bag	O - toy	eee - chips	aa - star	Pa (pani	mm (music)	6	0	1	0
93	**3.6**	RCH	5.5	M	ASD	B	NV	Yes	3	V	76	76	Thee 3	moo cow says	eee	ma	go	ba (sheep _)	aa (echoic)	1	0	3	3
94	**3.7**	DRO	2.9	M	ASD	B	NV	Yes	3	V	172	229	Po (pour)	Sa (sand)	Pae du (play doh)	Kootu (scooter)	Ocku (rocker)	Massa (massage)	Camea (Camera)	0	7	0	0
95	**3.7**	VPR	4	M	ASD	B	NV	Yes	3	V	157	159	jum (jump)	Pop	Car	Toy	Out	Bo (ball)	€	7	0	0	0
96	**3.7**	SPA	4.7	M	ASD	D	NV	Yes	3	V	37	51	Baa	O	Meow	Boo	hisss	papa	wool	0	0	7	0
97	**3.8**	KGR	4.11	M	ASD	D	NV	Yes	3	V	100	516	Aa (aao)	Go (ready)	ee (chips)	Aa (star)	Moo (cow)	ee (1,2_)	Boo (boogie..)	2	0	5	0
98	**3.8**	AJA	4.2	M	ASD	N	NV	Yes	3	V	11	180	Ba ba	Go (ready _)	WEE	Moo	Neigh	aa	tooee too	0	0	6	1
99	**3.8**	AJO	6.1	M	ASD	B	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
100	**3.8**	AV	2.3	M	ASD	B	NV	Yes	3	V	387	448	aaa (come)	No	give	leave	open	Come	Move	7	0	0	0
101	**3.8**	VKH	4.8	M	ASD	M	NV	Yes	3	V	4	50	bow bow	bubu (bubble)	cluck	oo(old mc..)	ee	pupu (johny..)	neh (neigh)	1	0	5	1
102	**3.9**	AMAL	4.5	M	ASD	D	NV	Yes	3	V	174	622	Aaa (aao)	Mmm (mGR)	ooo (out)	(Op) Open	Moo (Music)	u (up)	O (eeya eeya o)	6	0	1	0
103	**3.9**	NGA	2.8	M	ASD	M	NV	Yes	3	V	365	462	Toy	Eya Eya oH	bow bow	Biscuit	car	open	Toile	0	5	2	0
104	**3.9**	ARA	3.2	M	ASD	M	NV	Yes	3	V	45	219	bow bow	open	push	bubu-bubble	apa - johnny johnn	O (ol mac)	dance	1	3	3	0
105	**3.9**	ISK	2.11	F	ASD	B	NV	Yes	3	V	32	344	Baba (sheep)	Go (ready...)	Moo..(cow)	caee - cake	pa (puzzle)	tha (star)	to - toy	3	0	4	0
106	**3.ss**	AMEH	3.9	M	ASD	B	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
107	**3.ss**	AKE	3	M	ASD	B	NV	Yes	3	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
108	**4.1**	SVE	4.4	F	ASD	N	NV	Yes	4	V	30	87	Chocolate	Ba ba	Oo (ol mac)	Water	star (twinkle)	papa johnny	wool(ba ba black..)	0	2	5	0
109	**4.1**	KLA	1.11	M	ASD	D	NV	Yes	4	V	14	92	ba sheep says	moo	Music	ribit (frog says)	Turn	Chips	Bubbles	0	4	3	0
110	**4.1**	JJO	4.11	M	ASD	N	NV	Yes	4	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
111	**4.1**	KAM	3.4	M	ASD	B	NV	Yes	4	V	12	34	Bow bow	Star	O	Ma	Pa	Ne-Ne (Neigh-neigh)	Go	0	1	4	2
112	**4.1**	SAG	1.8	M	ASD	N	NV	Yes	4	V	10	29	Ba ba	Moo	Kurkure	Come	chi	Pani	3	0	3	4	0
113	**4.2**	Narvey	5.6	M	ASD	M	NV	Yes	4	V	35	73	bow bow	ha ha	meow	go	cluck	eat (its time to)	mu-mu	0	0	7	0
114	**4.2**	Huber	5.2	M	ASD	N	NV	Yes	4	V	7	19	Go (ready..)	Yes papa	Push	Home	Hurry	Duck	Moo	0	1	6	0
115	**4.2**	Rita	4.1	F	ASD	B	NV	Yes	4	V	7	21	Toy	bubble	go(ready…)	music	move	jump	1, 2, 3	0	5	2	0
116	**4.3**	Lika	2.11	M	ASD	N	NV	Yes	4	V	83	151	bu (bubble)	aa	eee	oo	Mu	Ba ba (sheep..)	Go (ready...)	1	0	2	4
117	**4.3**	Junaid	5.6	M	ASD	B	NV	Yes	4	V	8	94	Go(ready..)	Ba ba(sheep)	Ball	Water	Apple	Open	Come	0	5	2	0
118	**4.3**	Hans	2.11	M	ASD	M	NV	Yes	4	V	46	76	ba ba (sheep)	chip	bishit	watu	go (ready)	swi (swing)	caa (come)	0	5	2	0
119	**4.4**	CGO	3	M	ASD	B	NV	Yes	4	V	15	75	music	Moo moo	Baba - sheep	3	jump	go (ready steady)	Kaa kaa(crow...)	0	2	5	0
120	**4.4**	RKAY	6.1	F	ASD	M	NV	Yes	4	NV	0	0	0	0	0	0	0	0	0	0	0	0	0
121	**4.4**	MMA	3.3	M	ASD	H	NV	Yes	4	V	6	10	water (to-ta)	tee saw(see-saw)	come (tum)	toy (toe)	pin-spin	nusik - musik	Avi (carry)	0	7	0	0

S.No	MBL	Code	Age at intake Yr.Mth	Gender	Diagnosis	Loc	Baseline Vocal Status	Inclusion Status	Expt. No	Final Vocal Status	Days to FV	Days to 7v	V1	V2	V3	V4	V5	V6	V7	EM	M	IV	Ech
122	**4.4**	JRA	9.2	M	ASD	B	NV	Yes	4	V	35	155	moo(cow says)	bu - sheep	iss - smake	a johnny	o -eeya o	ne - donkey says	I(diamond in..)	0	0	7	0
123	**4.5**	RGA	8.6	M	ASD	B	NV	Yes	4	V	136	338	Pus (push)	Massa (massage)	Go	Piyo (pillow)	Moo(move)	No	Oni (onion)	2	5	0	0
124	**4.5**	JBH	6.4	M	ASD	B	NV	Yes	4	V	74	162	O (old mc….)	mm(music)	ooo	ba (bubble)	pus (push)	foo (blow)	A(twinkle..)	5	0	2	0
125	**4.5**	AAA	7.2	M	ASD	N	NV	Yes	4	V	28	55	jhula (swing)	Bow	Papa	Little star	star	Ba ba	Chuk Chuk	0	1	6	0
126	**4.5**	VKA	6.11	M	ASD	B	NV	Yes	4	V	5	7	Baloon	Chips	Swing	Candy	Kurkure	Biscuit	Water	0	7	0	0
127		NIT	4.10	F	None	B	NV	No															
128		ARO	3.10	F	None	B	NV	No															
129		NPA	4.10	M	<6mths	M	NV	No															
130		IYA	6.5	M	None	D	NV	No															
131		AGO	5.5	F	None	M	NV	No															
132		KGE	2	M	<6mths	M	NV	No															
133		JRO	4.3	F	<6mths	M	NV	No															
134		SSRI	6.7	M	No Report	N	NV	No															
135		OSA	4.6	M	No Report	B	NV	No															
136		AVI	4.4	M	GDD	B	NV	No															
137		APARI	4.3	M	<6mths	H	NV	No															
138		ARE	2.8	M	<6mths	H	NV	No															
139		AKI	2	M	<6mths	H	NV	No															
140		ABSH	3	M	<6mths	M	NV	No															
141		MAA	2.9	M	<6mths	H	NV	No															
142		VKU	7.2	M	<6mths	B	NV	No															
143		NSI	6	M	<6mths	B	NV	No															
144		SNE	3.4	M	<6mths	B	NV	No															

Note 1:
Gender
M : Male
F : Female

Note 2:
Loc: Location
B : Bangalore
D : Delhi
H : Hyderabad
M : Mumbai
N : Noida

Note 3:
Final Vocal Status
V : Vocal
NV : Non Vocal

Note 4:
Days to FV (First Vocal)
Days to 7V (Seventh Vocal)

Note 5:
V1, V2, V3, V4,V5, V6, V7
Vocal 1 To 7

Note 6:
EM: Echoic Mand
M : Mand
IV : Intraverbal
Ech : Echoic

TABLE 18

Treatment Integrity - All Experiments

Experiment 1: Mand Training

MBL No	% TI	Min	Max
1.0	89%	80%	93%
1.1	93%	87%	97%
1.2	89%	73%	100%
1.3	90%	73%	93%
1.4	89%	77%	97%
1.5	90%	77%	100%
1.6	91%	83%	97%
1.7	87%	77%	97%
1.8	88%	77%	100%
1.9	92%	83%	97%
1.10	90%	77%	93%
1.11	88%	73%	97%
1.12	87%	77%	100%
1.13	87%	80%	93%
TI Average	**89%**	**73%**	**100%**

Experiment 2: Mand Training

MBL No	% TI	Min	Max
2	86%	73%	93%

Experiment 2: Mand Training (with Time Delay)

MBL No	% TI	Min	Max
2	90%	83%	93%

Experiment 3: Mand Training

MBL NO	% TI	Min	Max
3.0	88%	57%	100%
3.1	90%	80%	97%
3.2	84%	60%	100%
3.3	86%	70%	93%
3.4	96%	67%	100%
3.5	86%	70%	97%
3.6	85%	73%	100%
3.7	87%	70%	93%
3.8	84%	70%	97%
3.9	84%	70%	90%
3.10	83%	70%	93%
TI Average	**86%**	**57%**	**100%**

Experiment 3: Intraverbal Training

MBL No	% TI	Min	Max
3.0	88%	67%	100%
3.1	82%	73%	93%
3.2	88%	80%	100%
3.3	89%	80%	93%
3.4	83%	73%	87%
3.5	85%	60%	93%
3.6	83%	73%	87%
3.7	92%	87%	100%
3.8	83%	73%	93%
3.9	84%	67%	93%
3.10	84%	80%	87%
TI Average	**85%**	**60%**	**100%**

Experiment 4: Mand Training

MBL NO	% TI	Min	Max
4.1	90%	87%	97%
4.2	83%	80%	87%
4.3	84%	80%	100%
4.4	87%	83%	93%
4.5	85%	77%	90%
TI Average	**86%**	**77%**	**100%**

Experiment 4: Intraverbal Training

MBL NO	% TI	Min	Max
4.1	87%	60%	93%
4.2	92%	73%	100%
4.3	87%	67%	93%
4.4	85%	73%	93%
4.5	88%	80%	100%
TI Average	**87%**	**60%**	**100%**

TABLE 19

IOA SCORES

IOA Score - All Experiment

Expt. No.	% IOA	Min	Max
1	89%	54%	100%
2	97%	94%	100%
3	88%	74%	97%
4	89%	83%	94%

Experiment 1

MBL No	% IOA	Min	Max
1	95%	91%	100%
1.1	83%	80%	86%
1.2	90%	83%	94%
1.3	87%	63%	100%
1.4	84%	80%	89%
1.5	91%	89%	94%
1.6	91%	86%	97%
1.7	97%	94%	100%
1.8	86%	80%	91%
1.9	91%	83%	97%
1.10	83%	80%	86%
1.11	94%	89%	100%
1.12	82%	54%	97%
1.13	91%	83%	100%
Total Study	**89%**	**54%**	**100%**

Experiment 2

MBL No	% IOA	Min	Max
2	**97%**	**94%**	**100%**

Experiment 3

MBL No	% IOA	Min	Max
3	89%	86%	94%
3.1	83%	80%	86%
3.2	90%	86%	97%
3.3	94%	91%	97%
3.4	87%	80%	94%
3.5	82%	74%	91%
3.6	89%	80%	97%
3.7	85%	80%	89%
3.8	88%	80%	97%
3.9	86%	80%	91%
3.10	87%	83%	91%
Total Study	**88%**	**74%**	**97%**

Experiment 4

MBL No	% IOA	Min	Max
4.1	89%	83%	94%
4.2	89%	86%	91%
4.3	86%	83%	89%
4.4	89%	83%	94%
4.5	91%	86%	94%
Total Study	**89%**	**83%**	**94%**

Table 20

Sign Mand Acquisition

S. No	MBL	Code Name	Sign-mands acquired prior 1st vocal	Comments
1.	1.12	ZMO	2	S
2.	1.12	VKI	2	S
3.	1.12	SAM	20	NV
4.	1.13	MAR	14	S
5.	1.13	AAK	11	S
6.	1.13	PKE	3	S
7.	1.11	SVEE	14	S
8.	1.12	AQU	2	S
9.	3.3	JSR	5	S
11.	3.3	SAV	12	S
12.	3.4	SVEN	24	S
13	4.4	MMA	0	V

NV: Non Vocal
S: Sign acquisition prior to vocal
V: Vocal prior to sign

Appendix 3

Figures

Figure: 1.0 Experiment 1

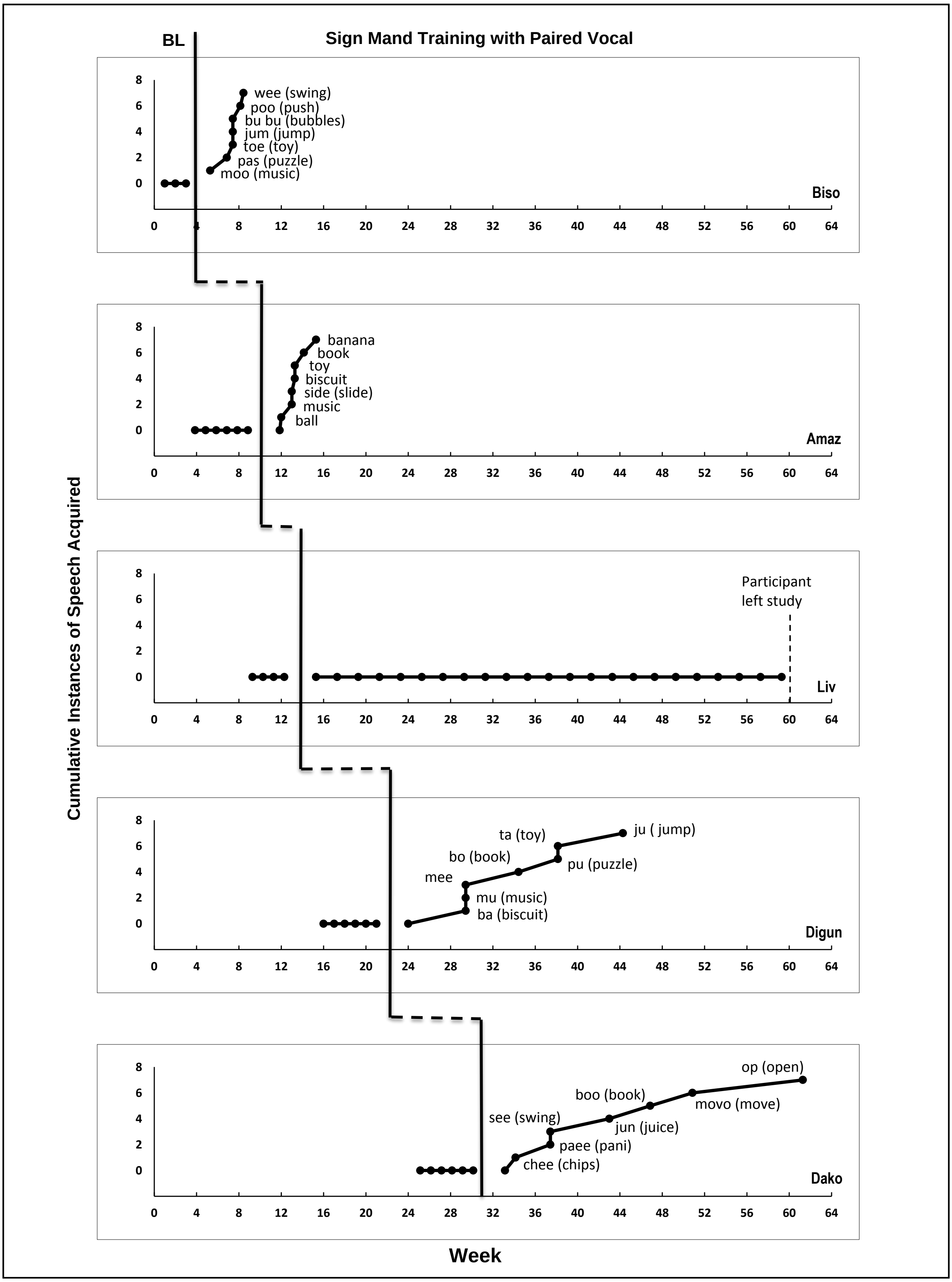

Figure 1.0: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.1 Experiment 1

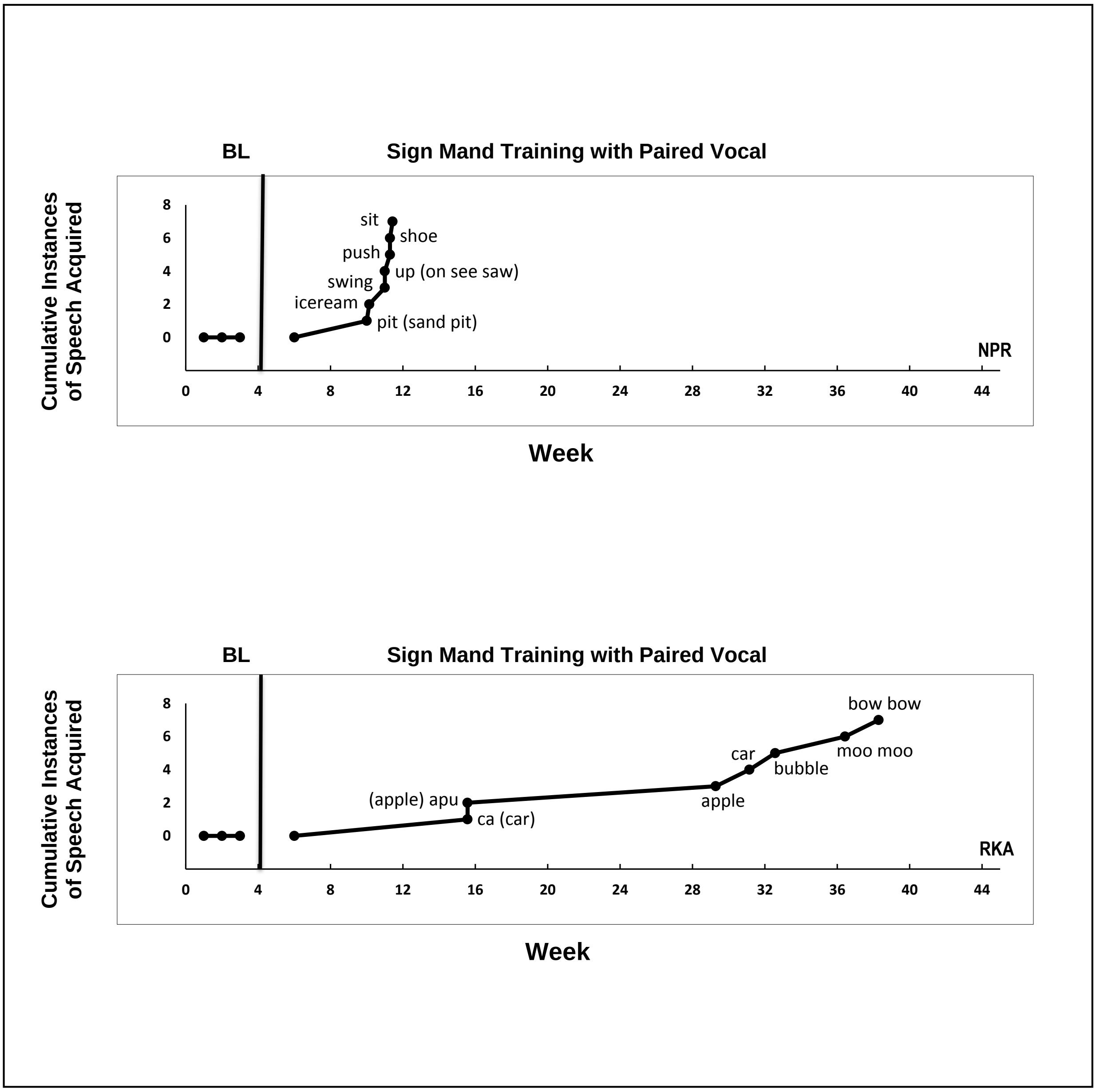

Figure 1.1: A single subject design to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism

Figure: 1.2 Experiment 1

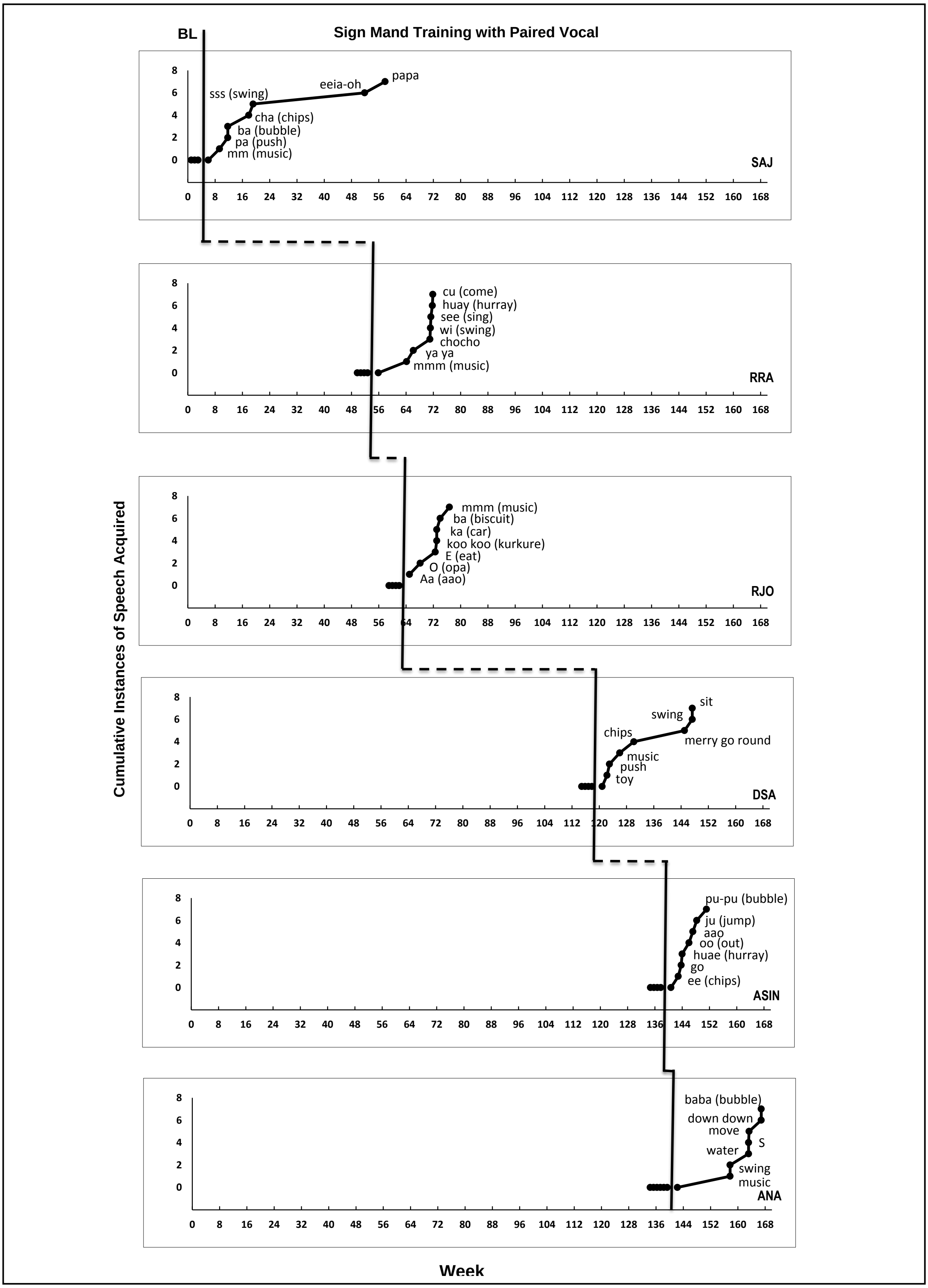

Figure 1.2: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.3 Experiment 1

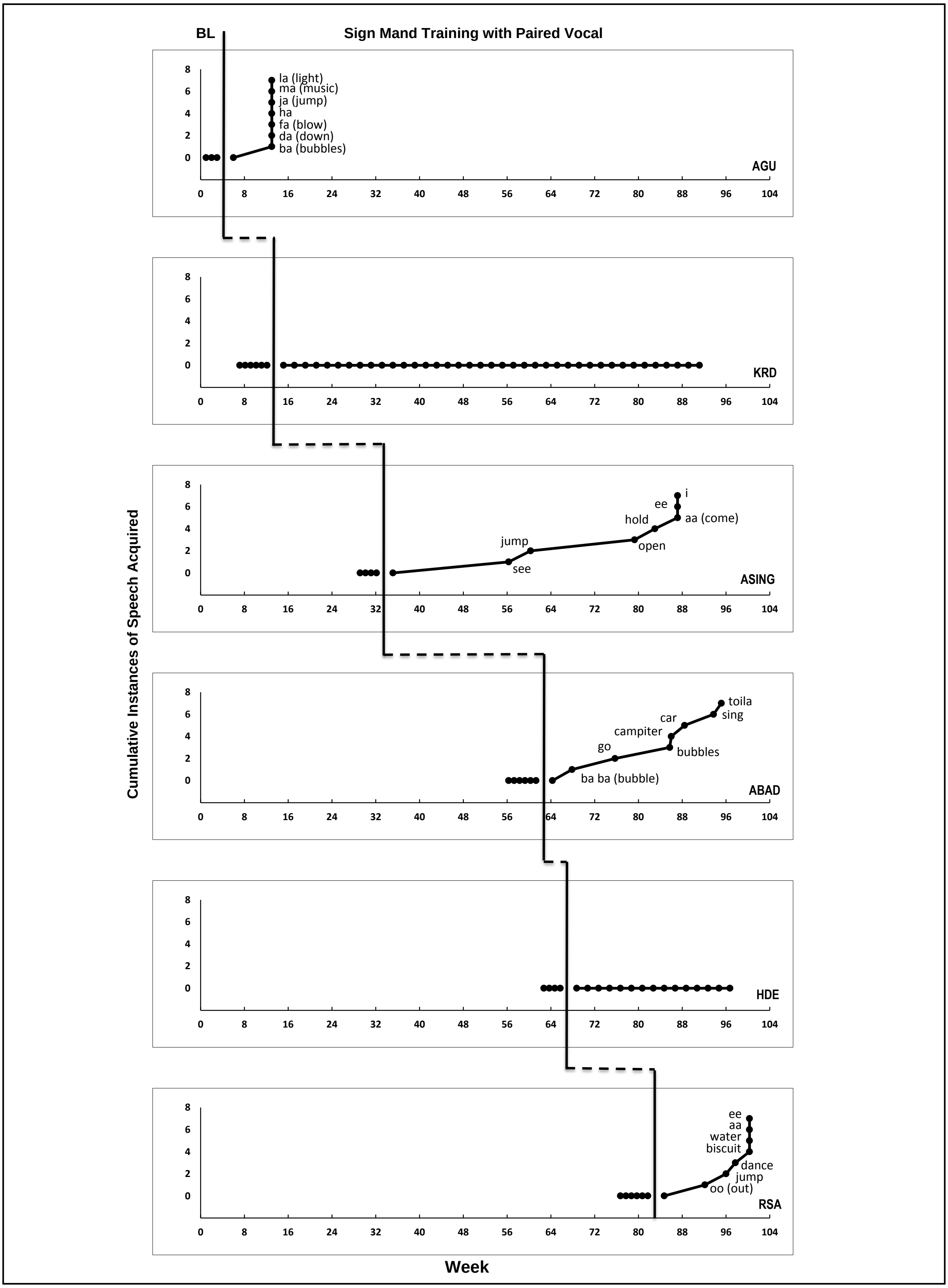

Figure 1.3: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism

Figure: 1.4 Experiment 1

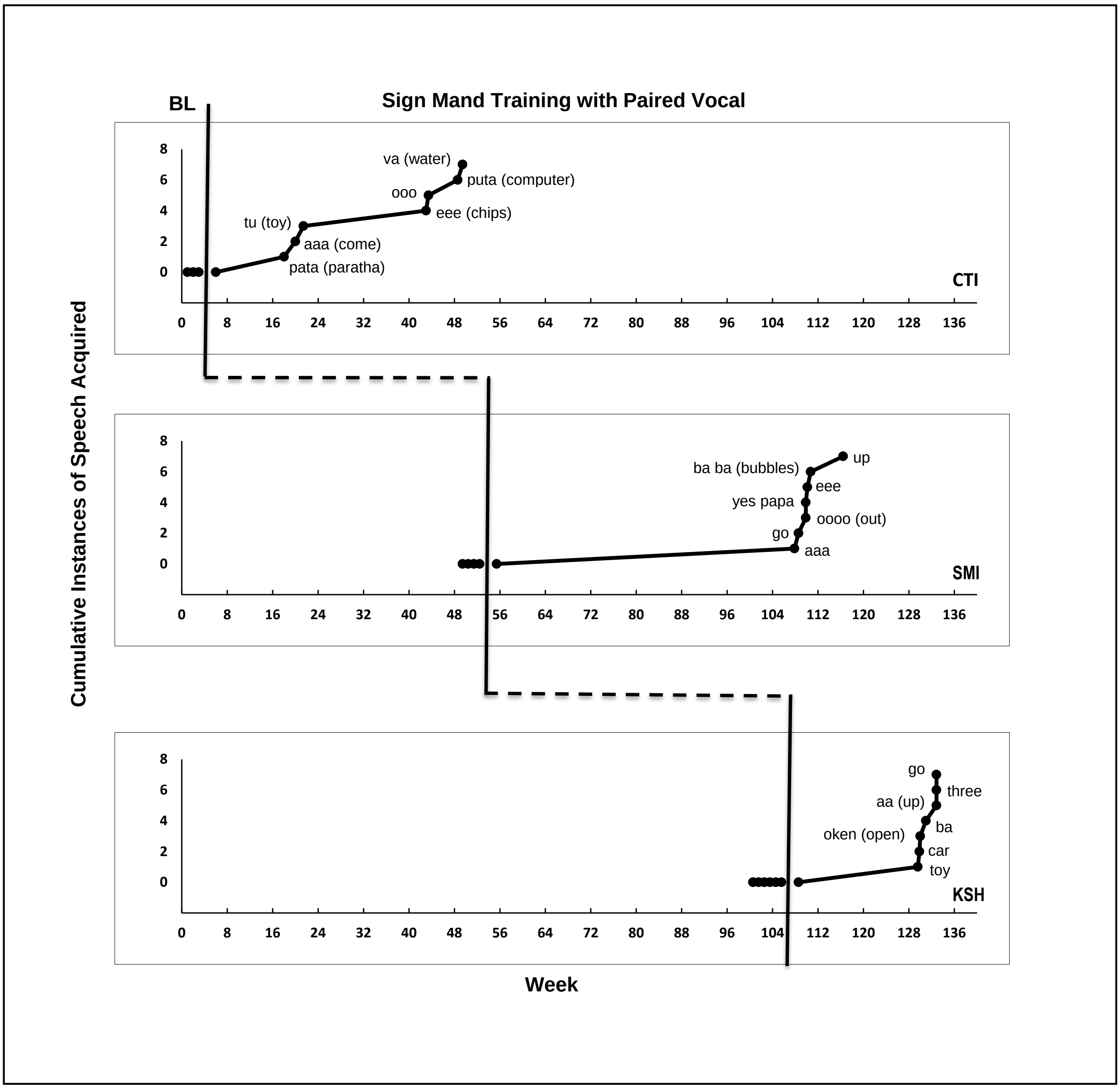

Figure 1.4: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.5 Experiment 1

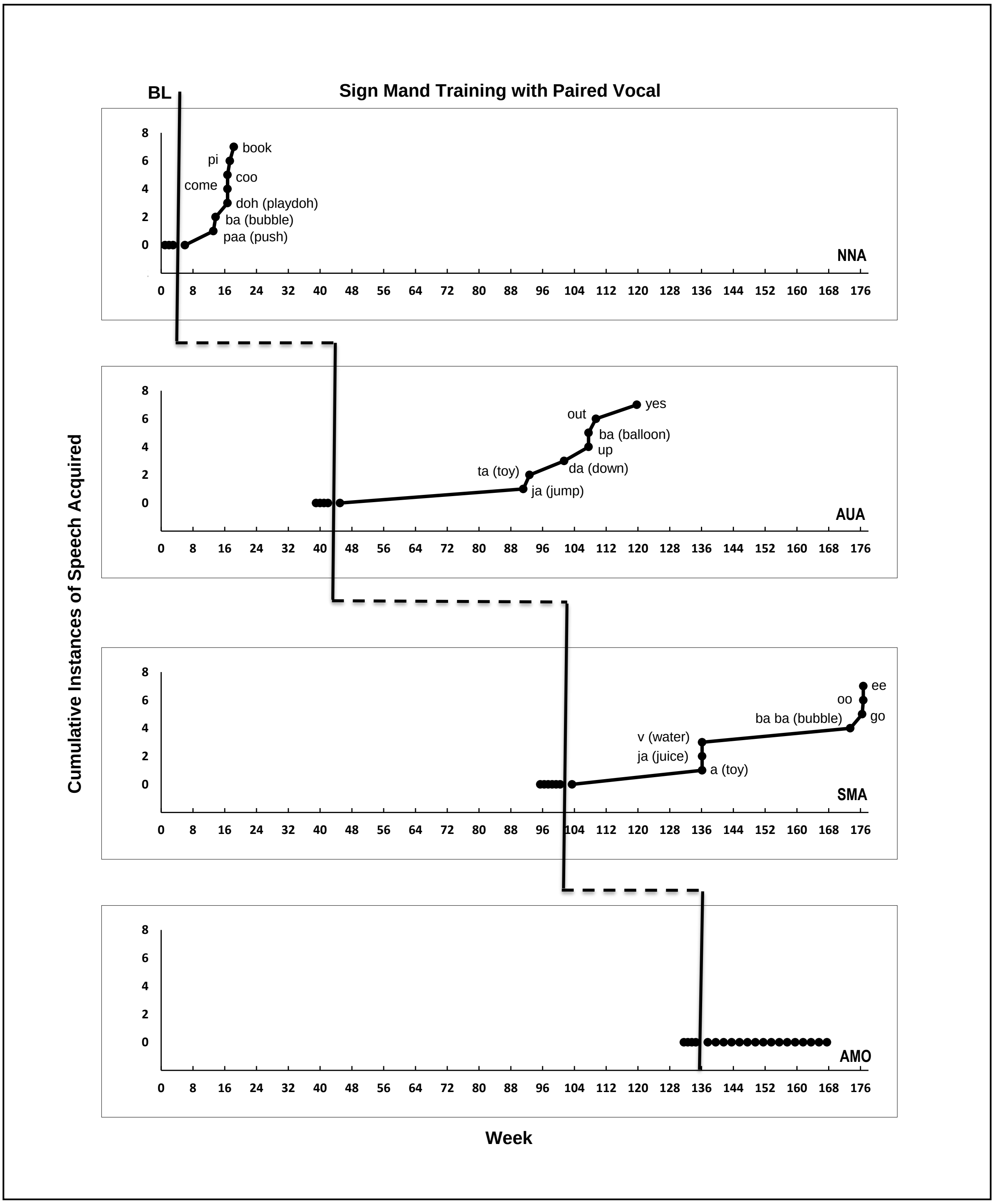

Figure 1.5: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.6 Experiment 1

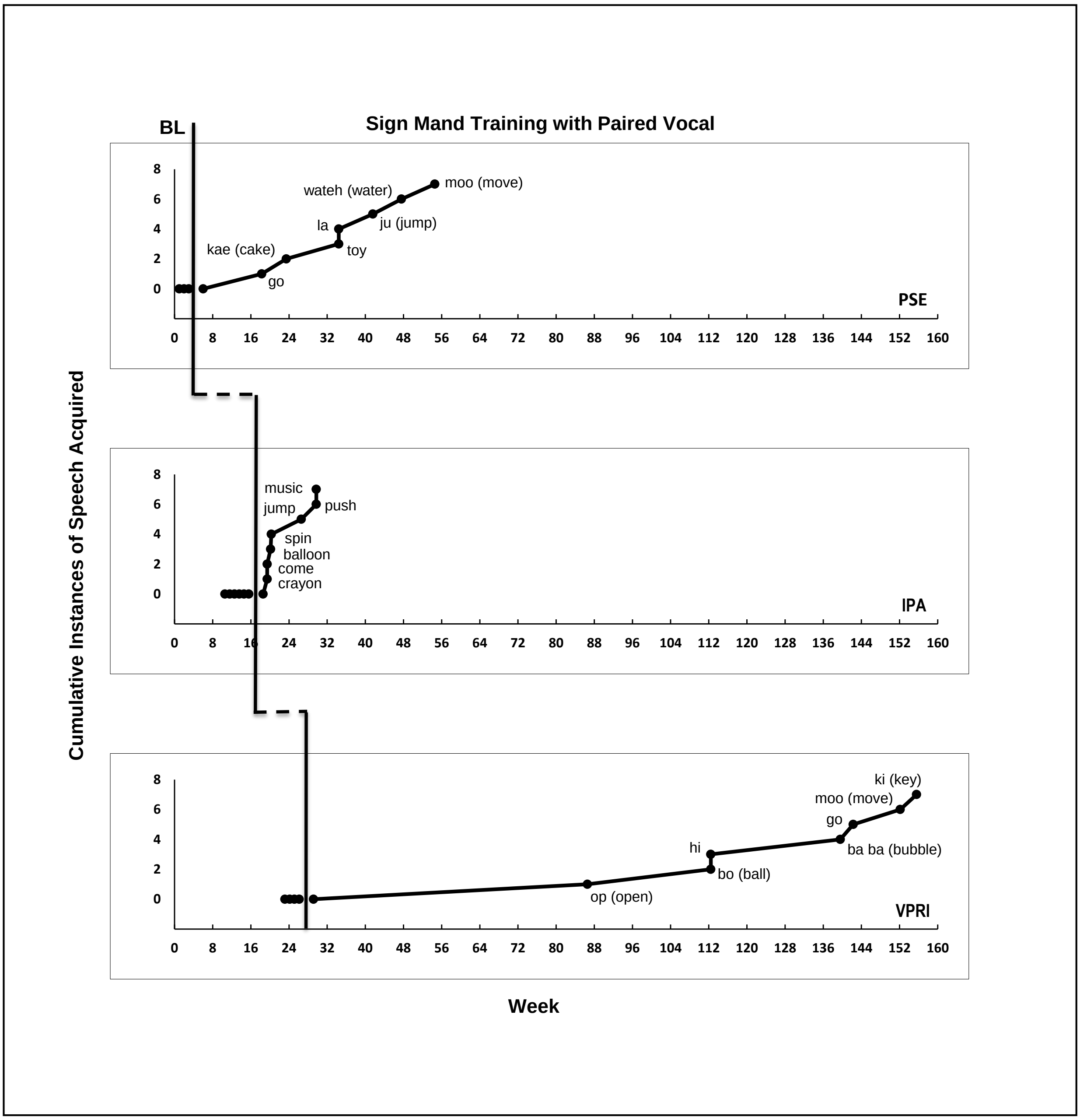

Figure 1.6: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.7 Experiment 1

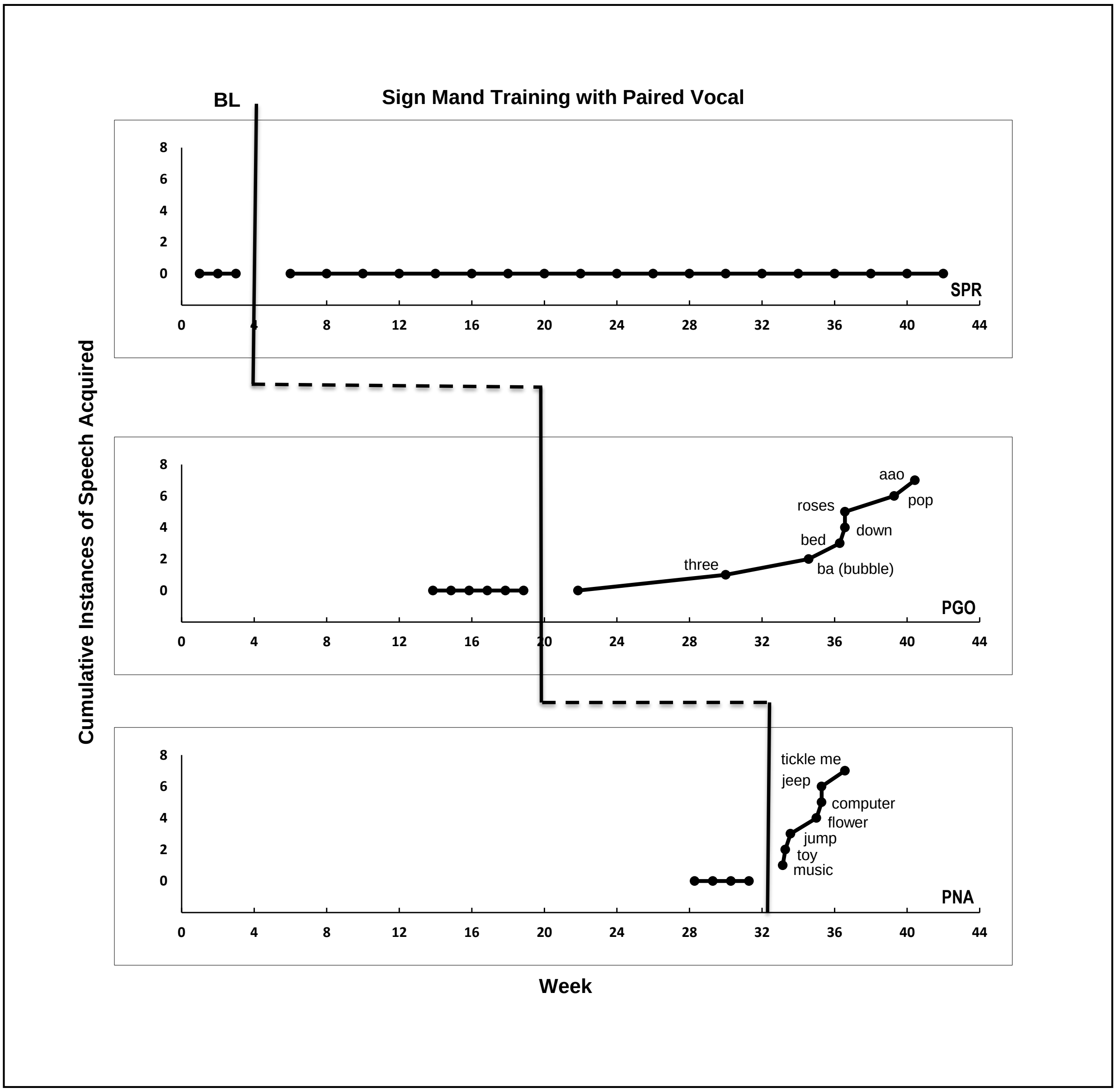

Figure 1.7: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.8 Experiment 1

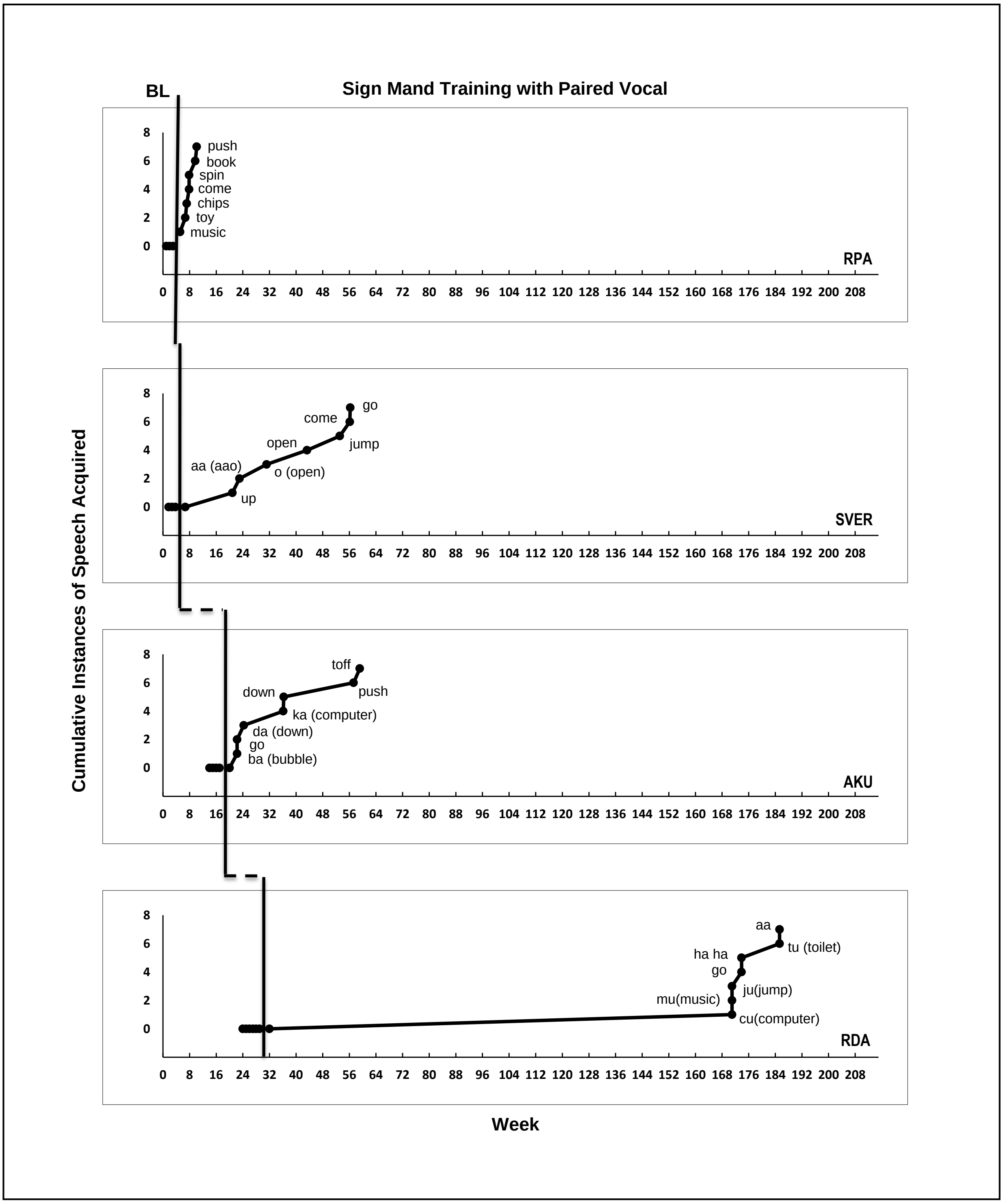

Figure 1.8: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.9 Experiment 1

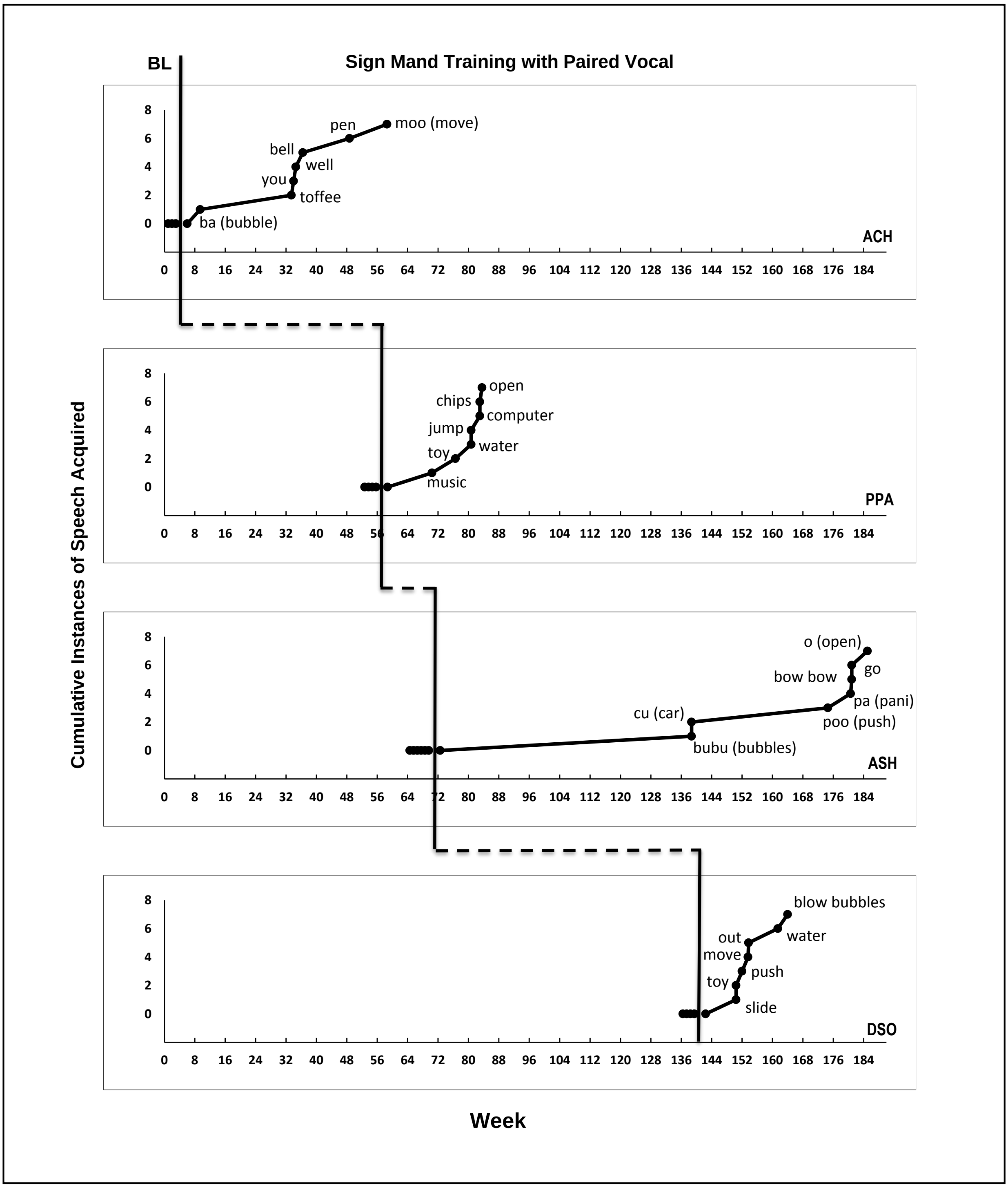

Figure 1.9: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.10 Experiment 1

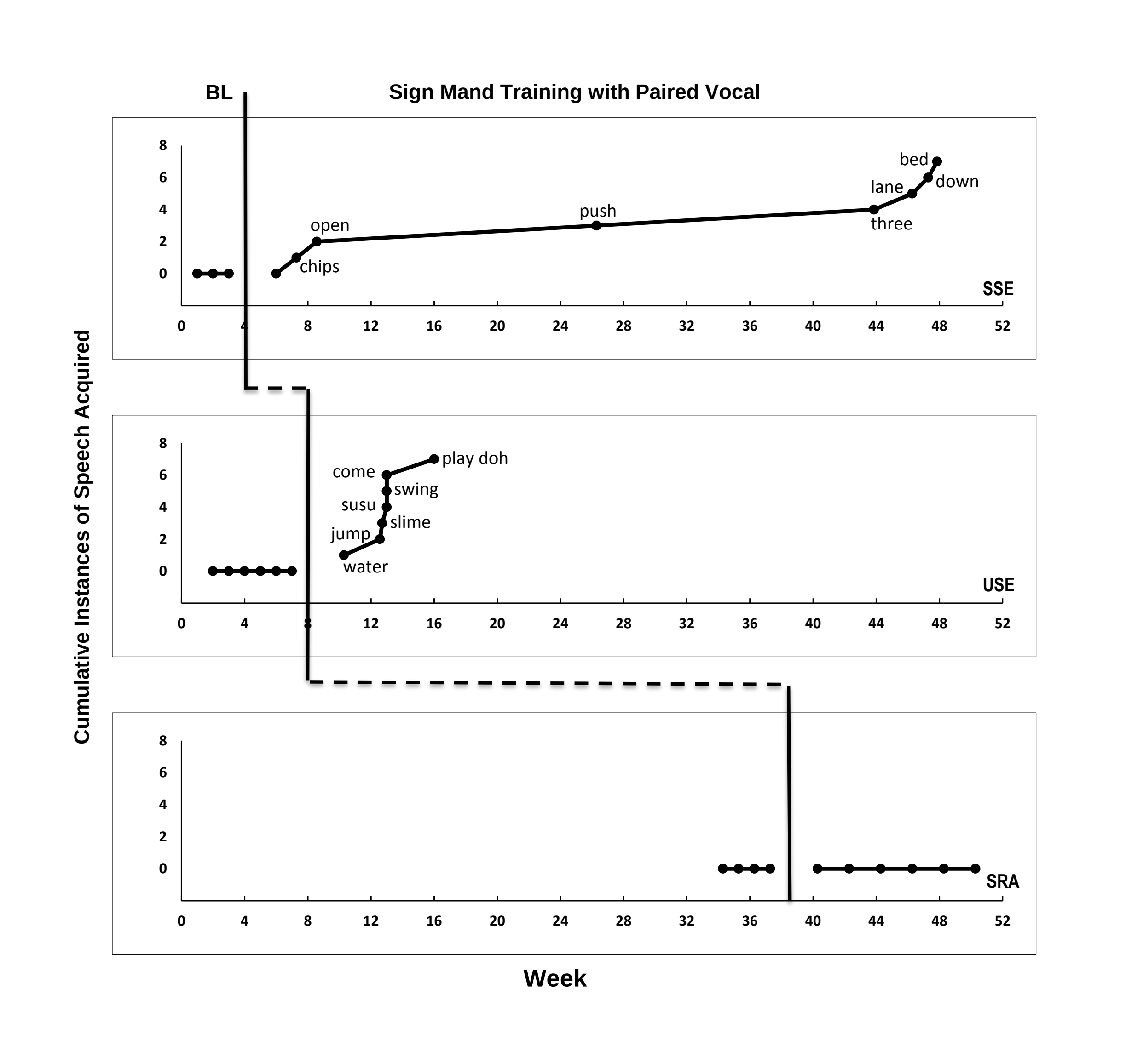

Figure 1.10: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.11 Experiment 1

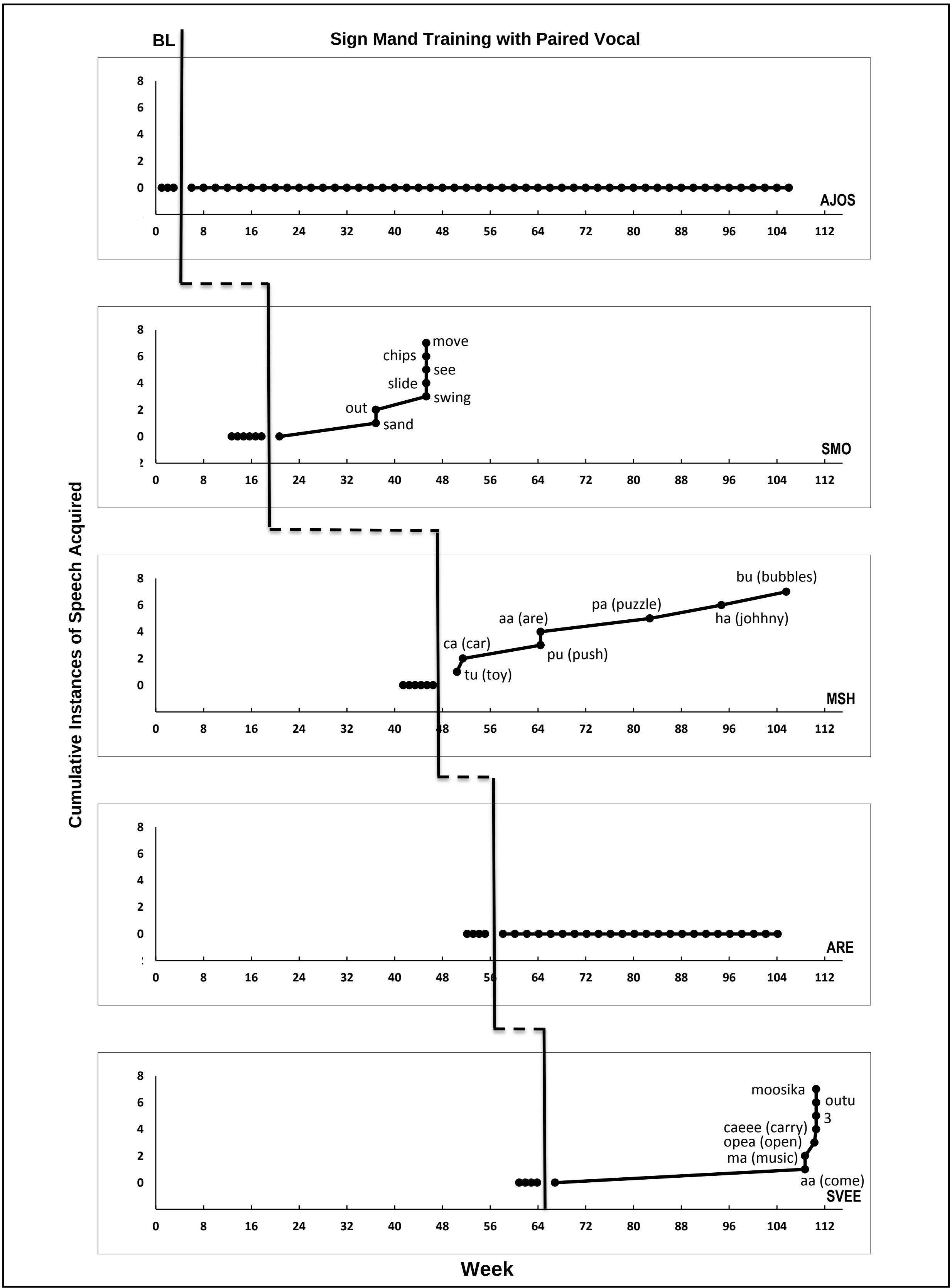

Figure 1.11: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 1.12 Experiment 1

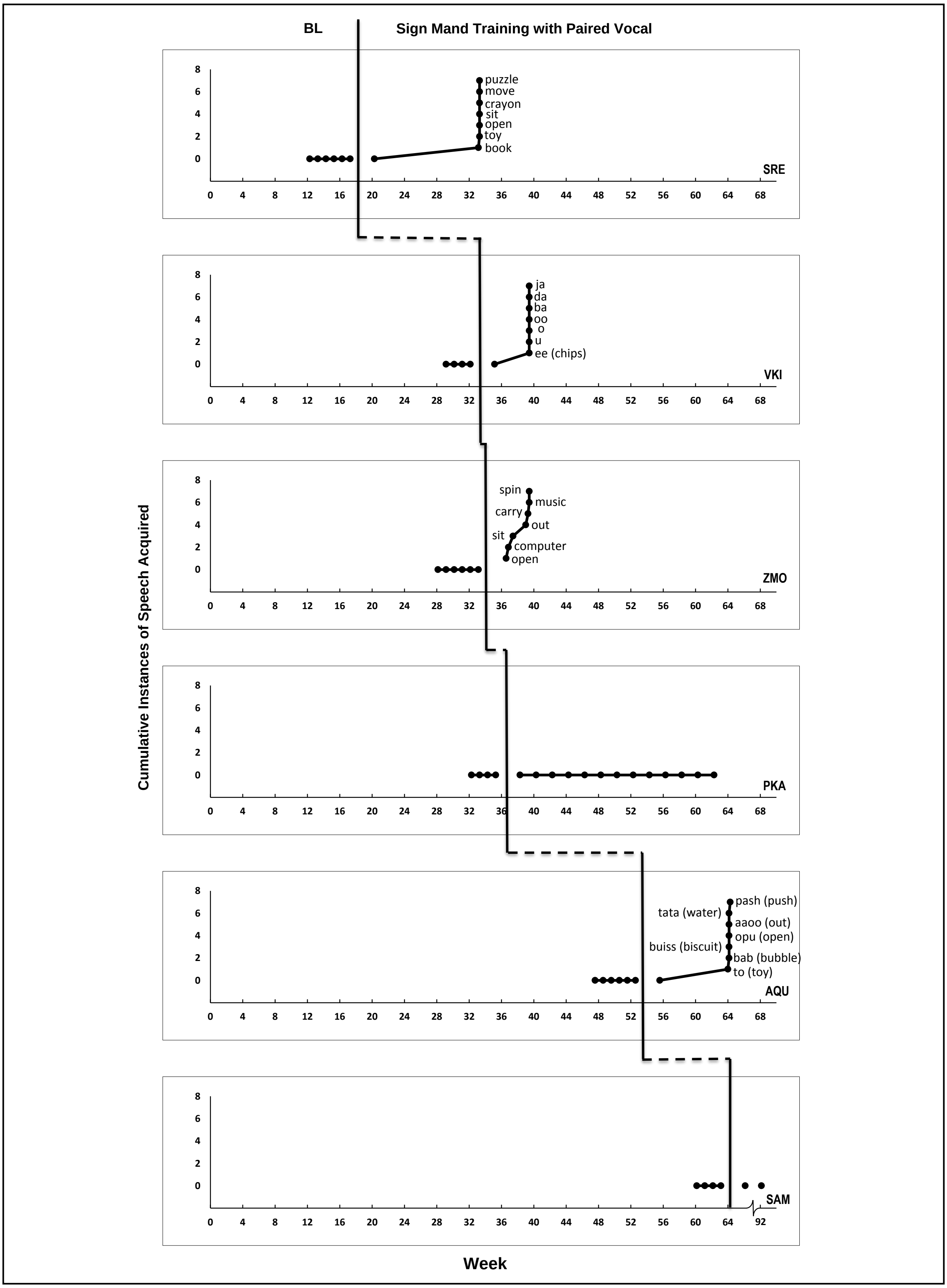

Figure 1.12: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism
Note: SAM remained non-vocal at the end of week 92 at which time this study ended

Figure: 1.13 Experiment 1

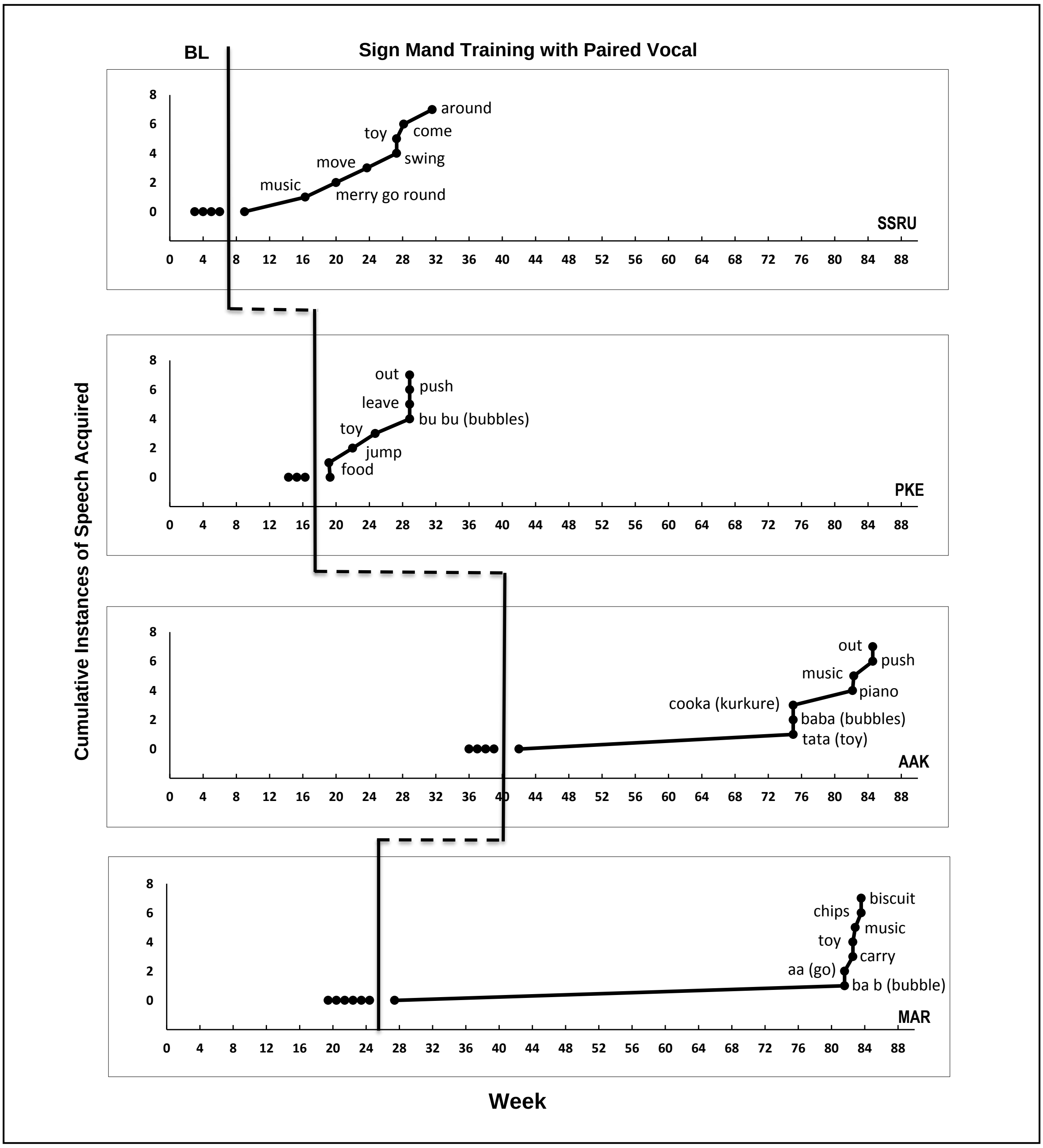

Figure 1.13: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in non vocal-verbal children with autism.

Figure: 2.0 Experiment 2

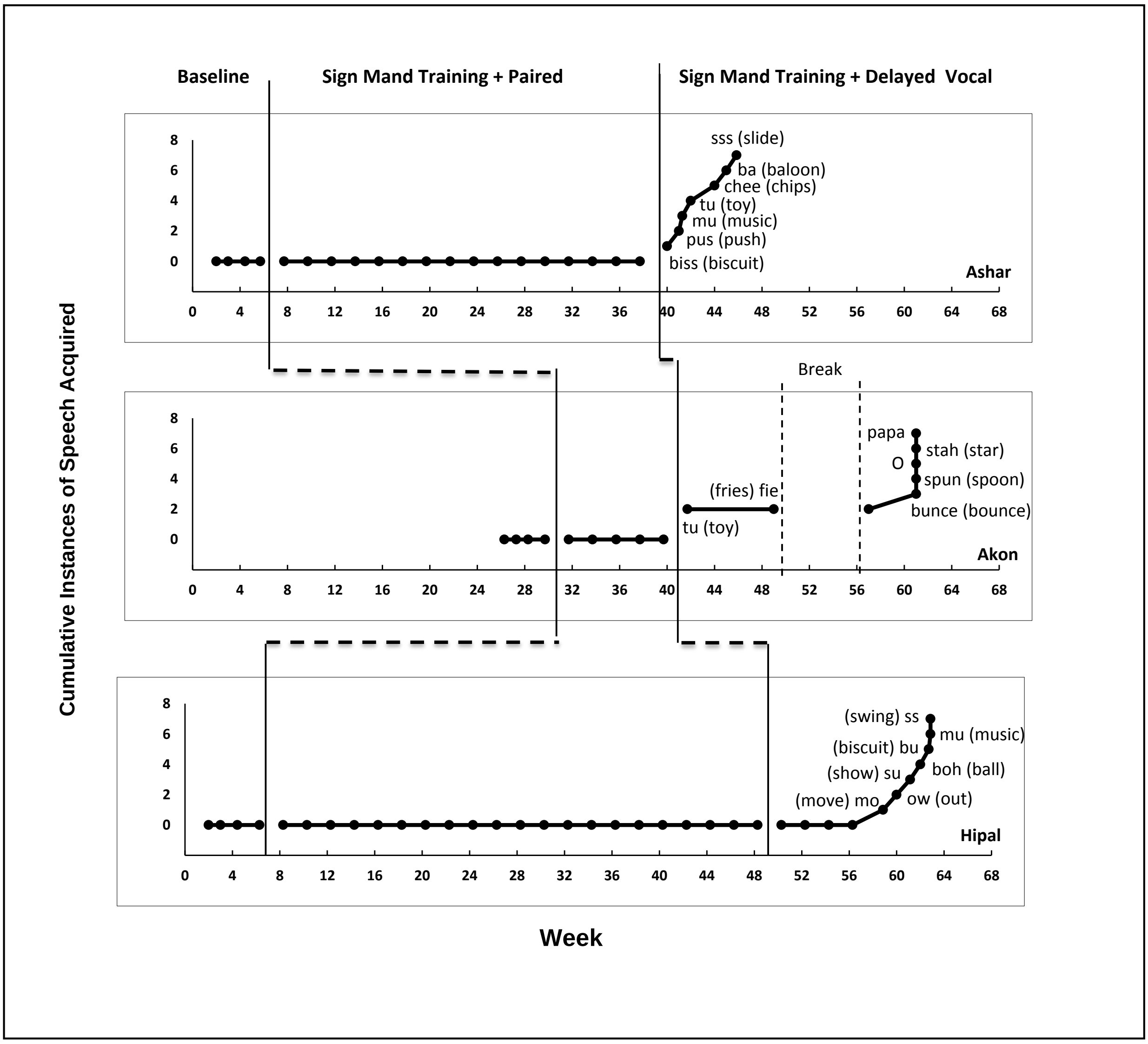

Figure 2.0: A multiple baseline across subjects to study the effect of delayed vocal auditory stimulus on acquisition of speech by children with autism undergoing sign mand training.

Figure: 3.0 Experiment 3

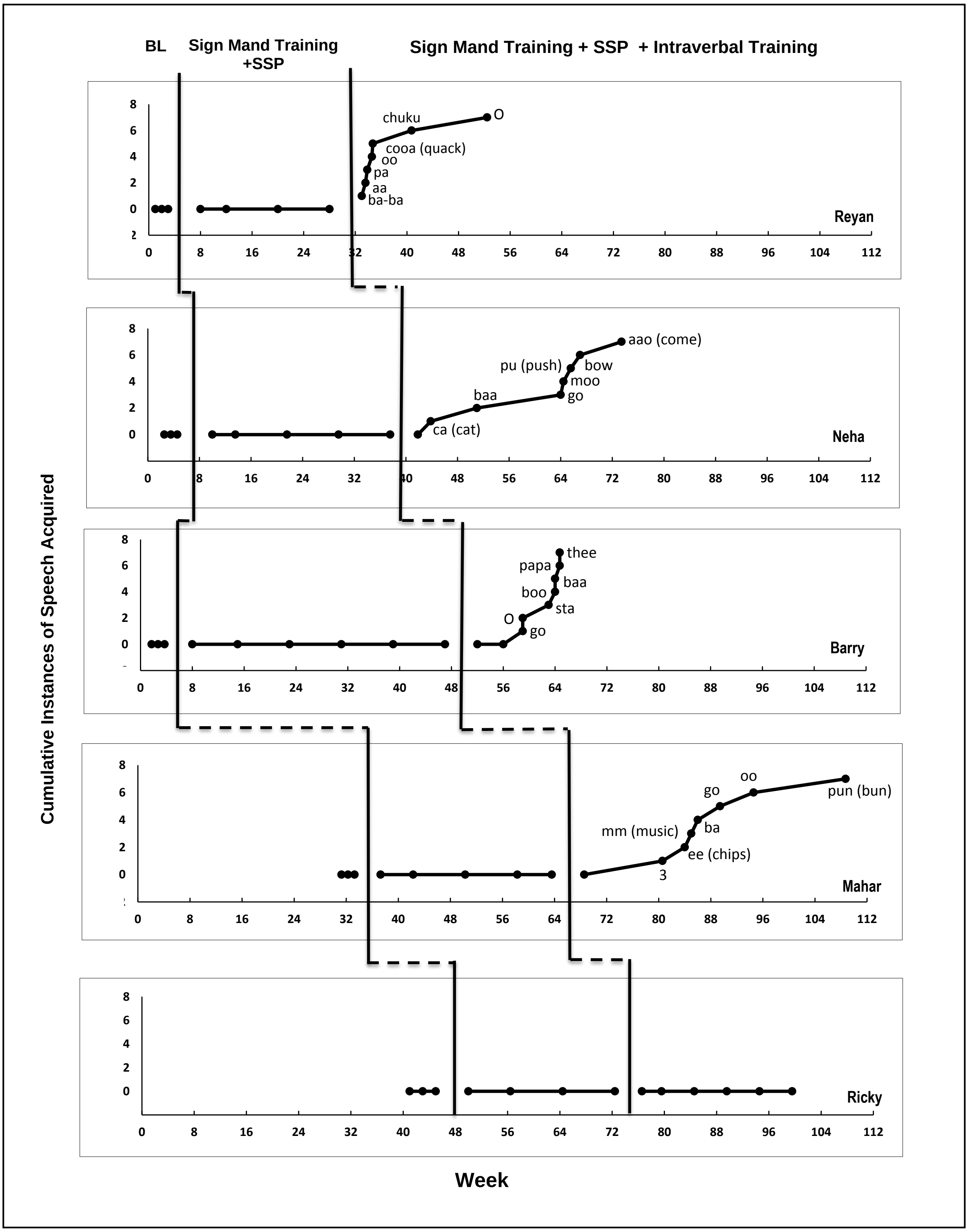

Figure 3.0: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.1 Experiment 3

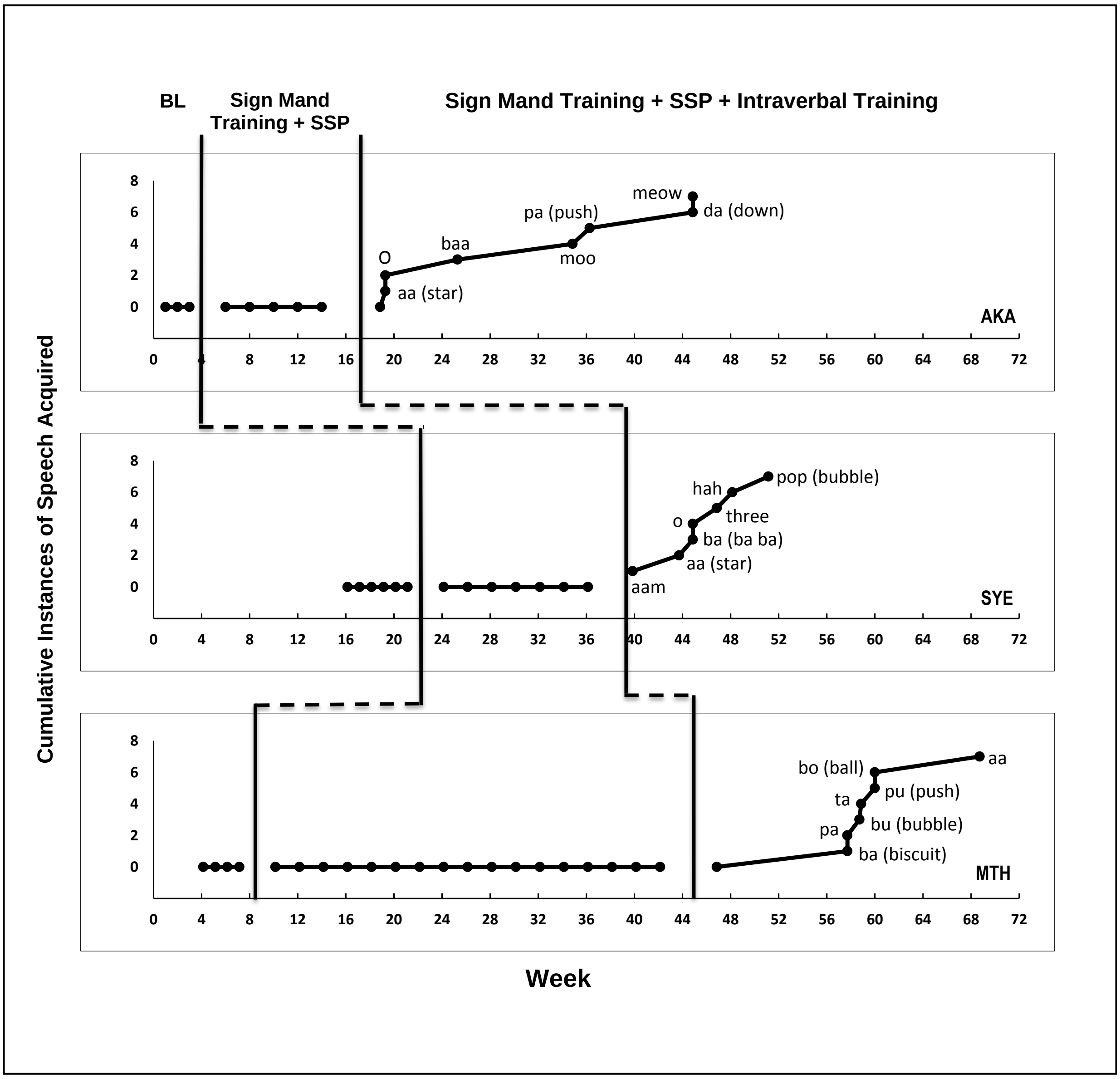

Figure 3.1: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.2 Experiment 3

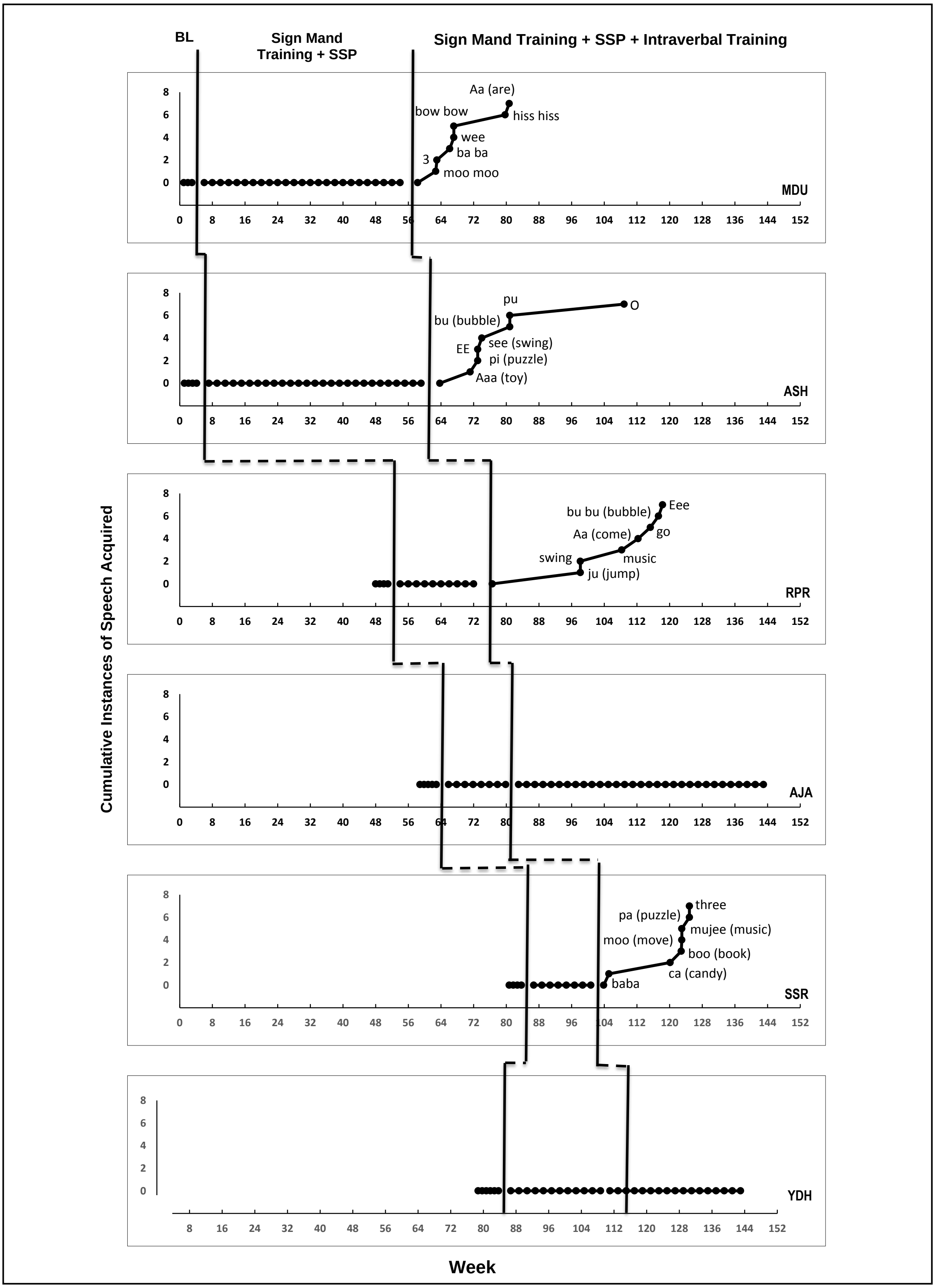

Figure 3.2: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.3 Experiment 3

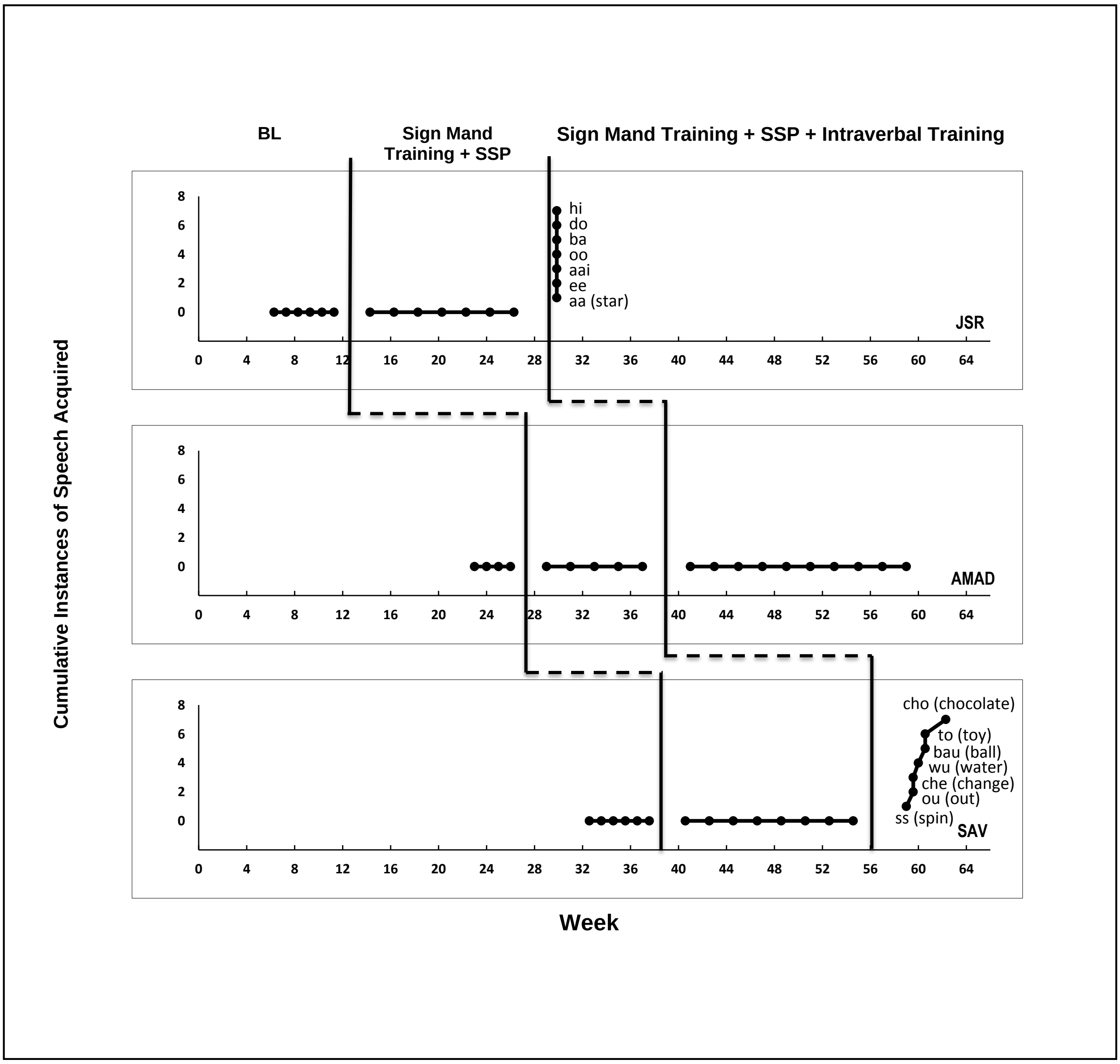

Figure 3.3: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.4 Experiment 3

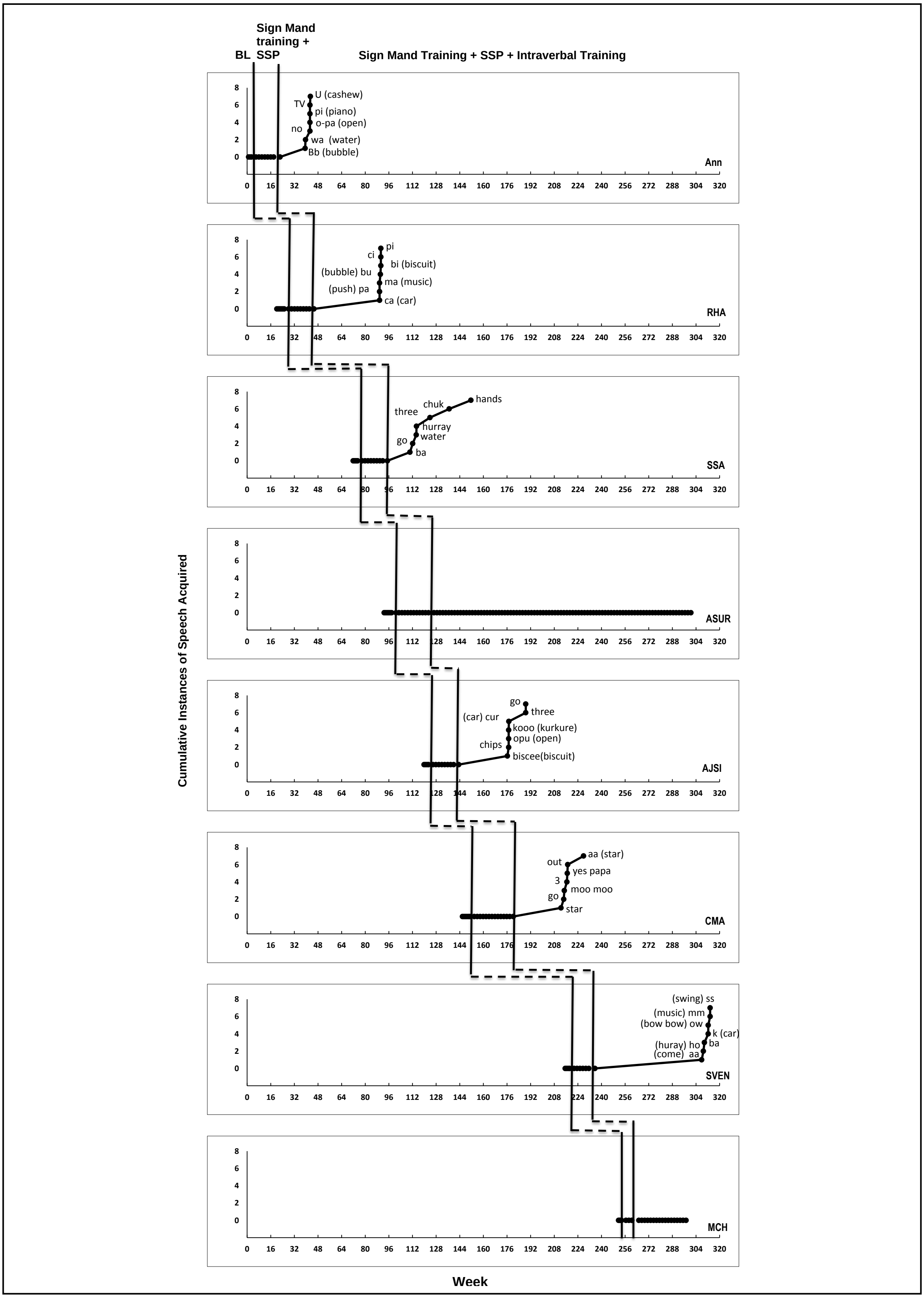

Figure 3.4: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.5 Experiment 3

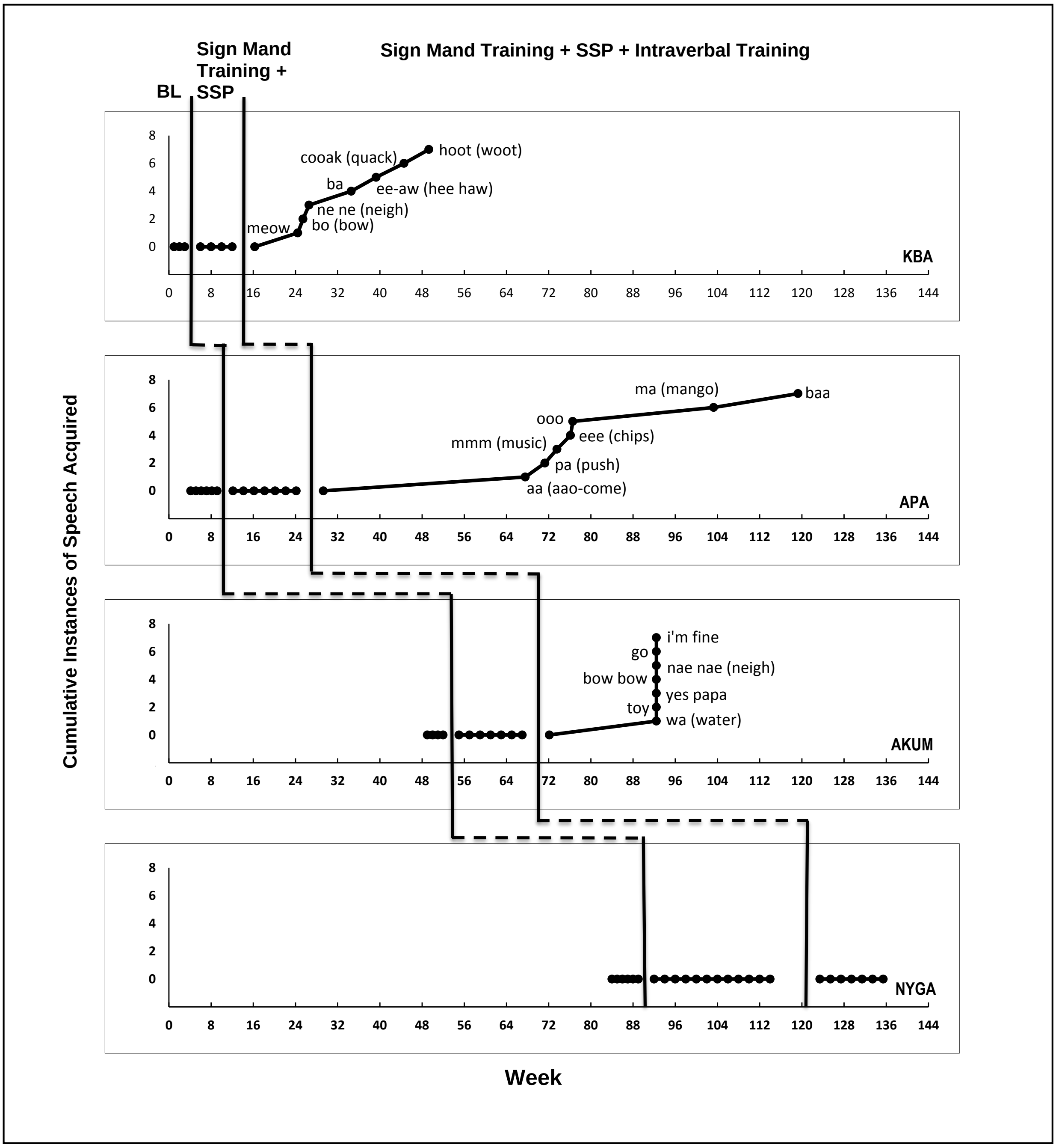

Figure 3.5: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.6 Experiment 3

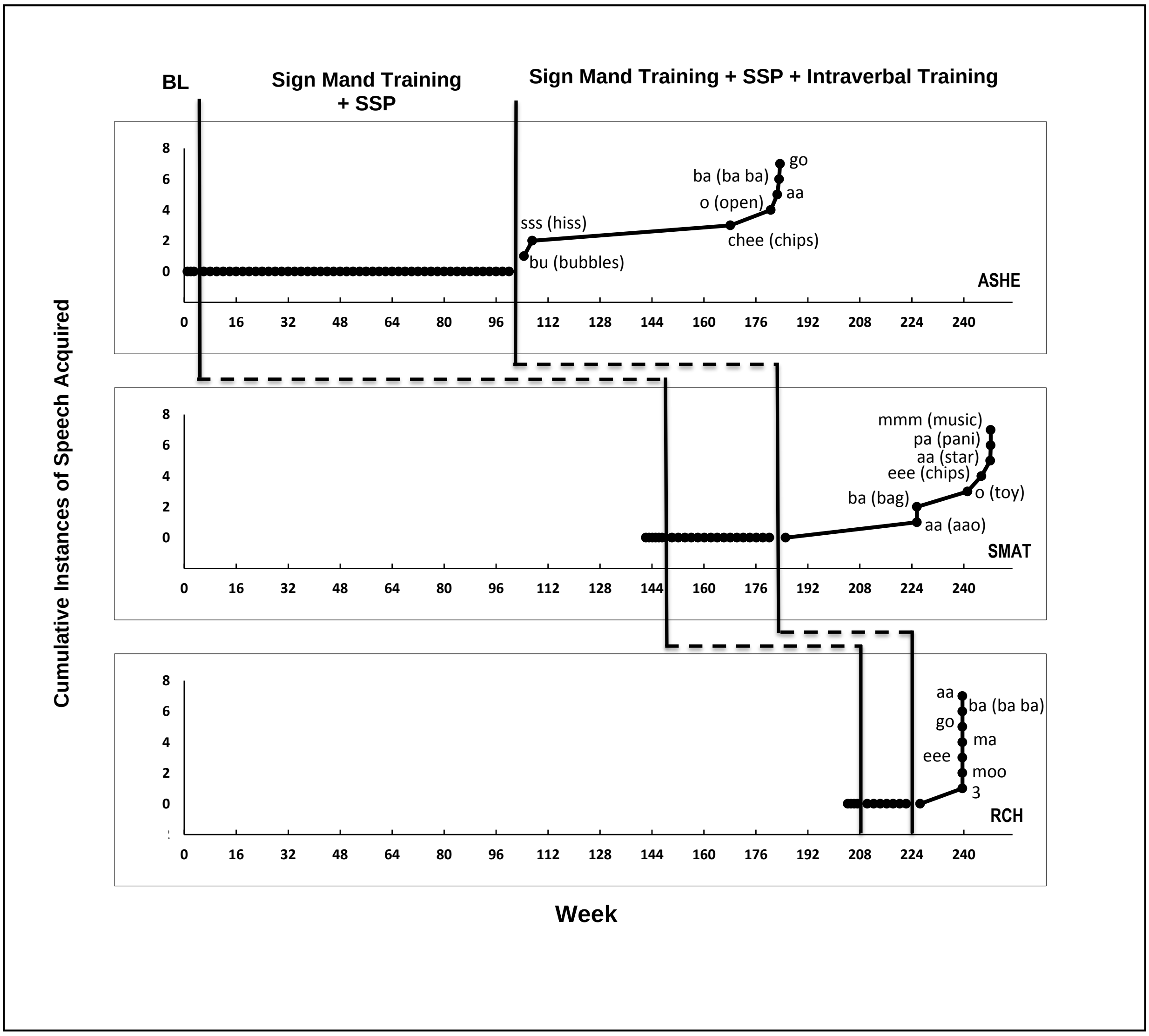

Figure 3.6: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.7 Experiment 3

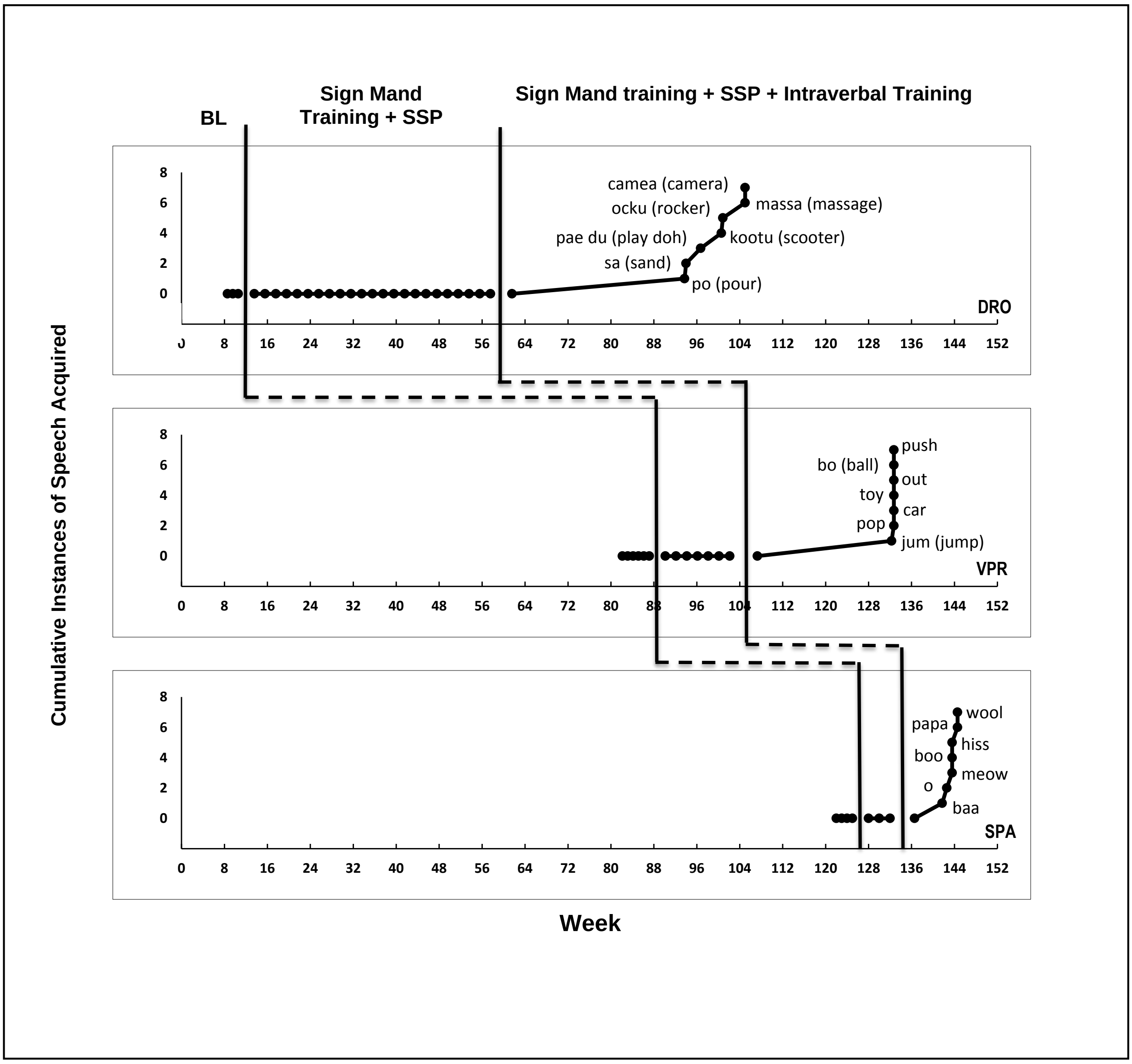

Figure 3.7: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.8 Experiment 3

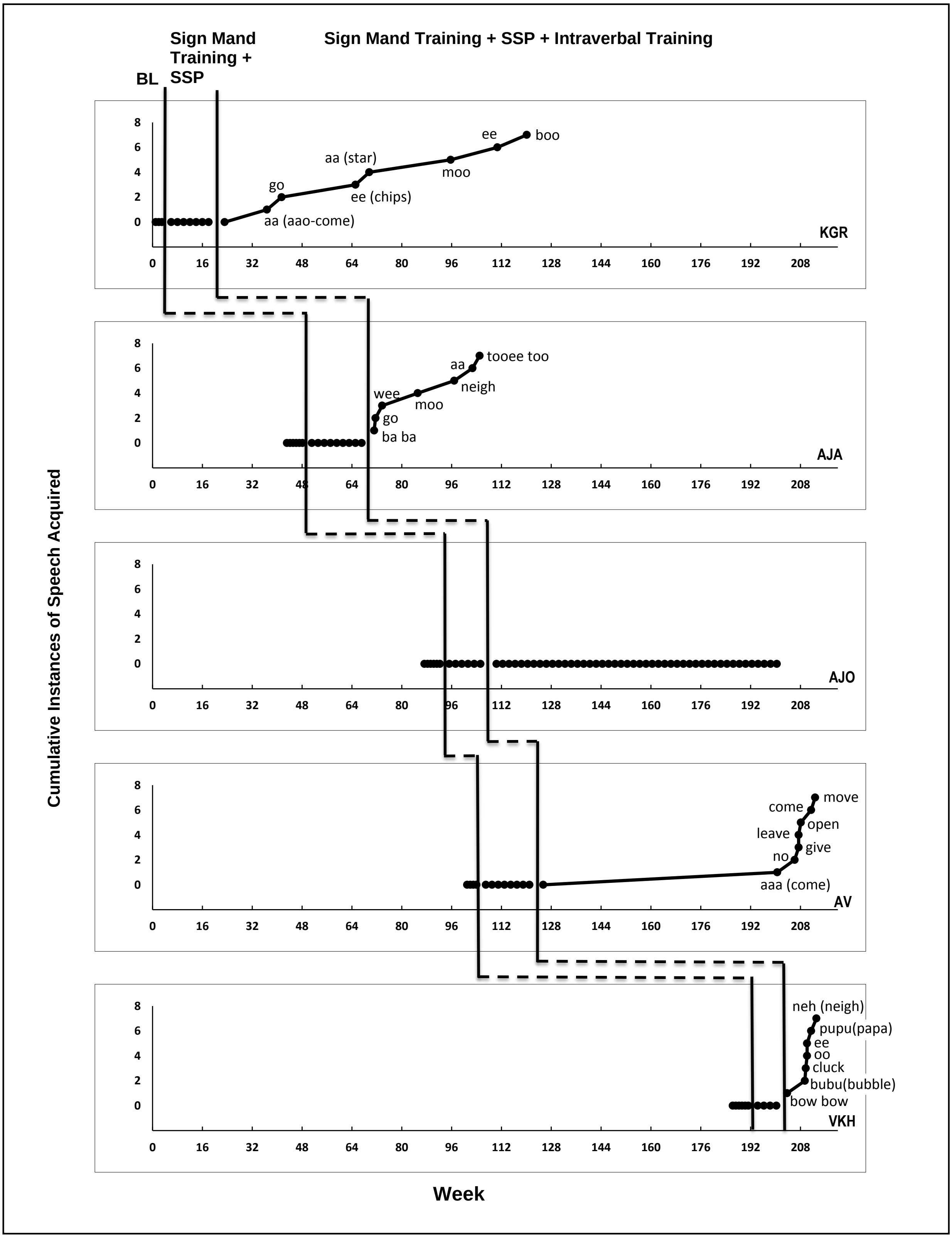

Figure 3.8: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.9 Experiment 3

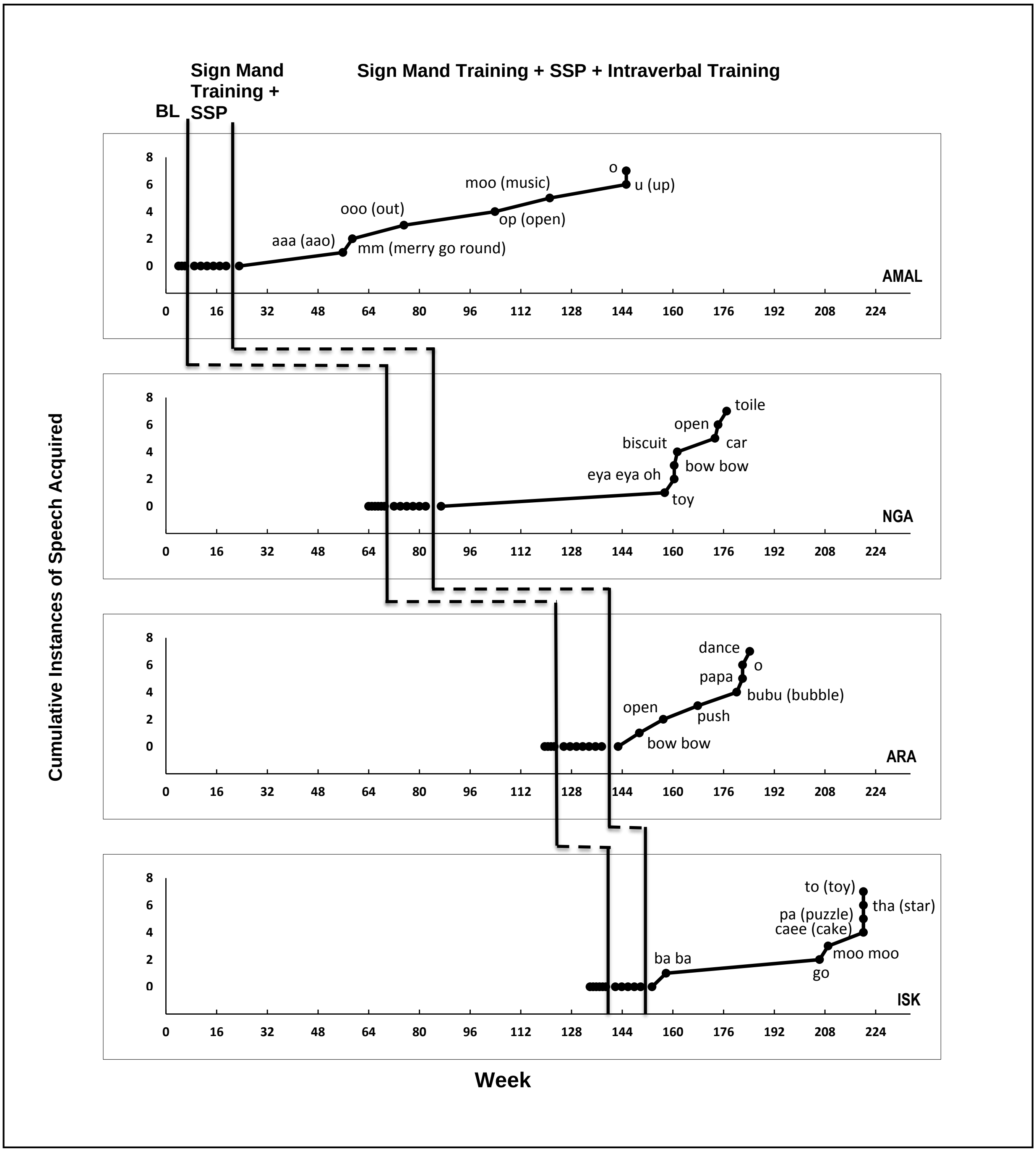

Figure 3.9: A multiple baseline across subjects to study the effect of adding intraverbal fill-in training to mand training with stimulus-stimulus pairing on non-vocal children with autism.

Figure: 3.10 Experiment 3

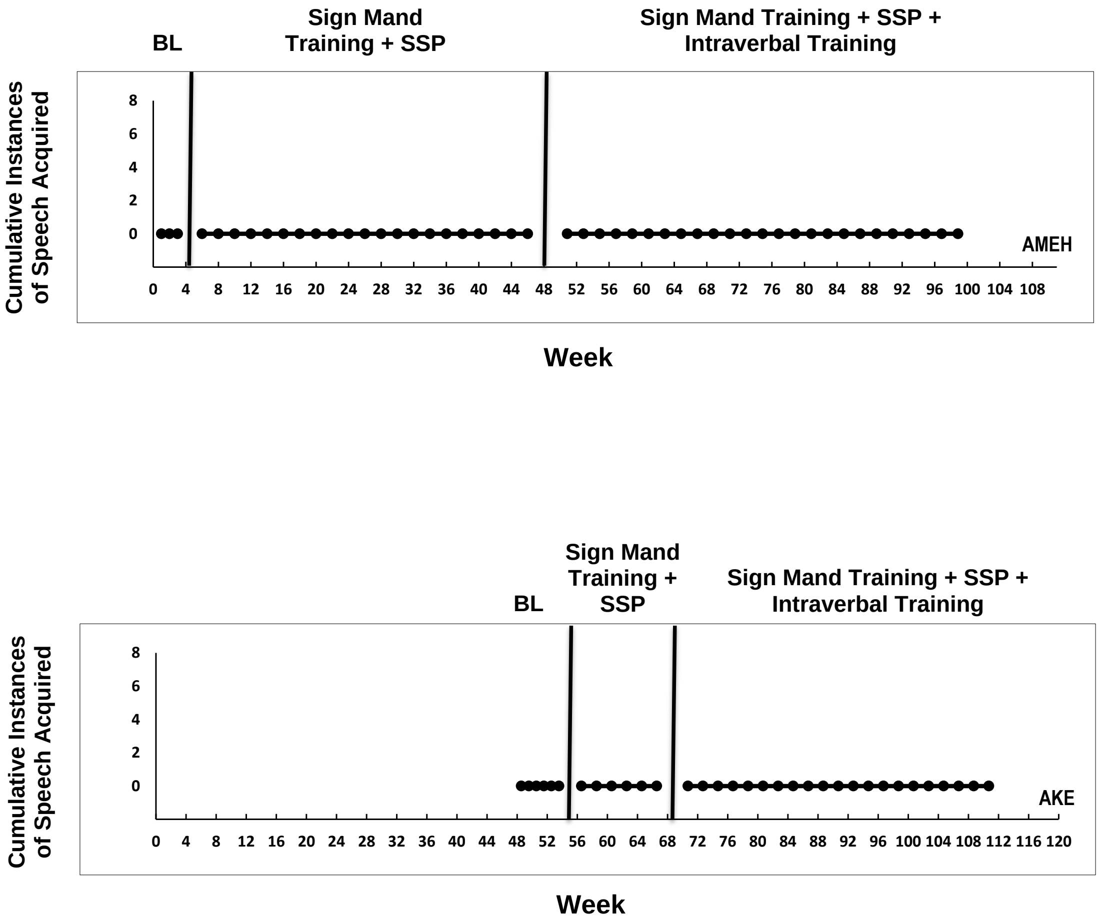

Figure 3.10: A single subject A-B design to study the effect of adding intraverbal fill in training to mand training with stimulus stimulus pairing on non-vocal children with autism

Figure: 4.1 Experiment 4

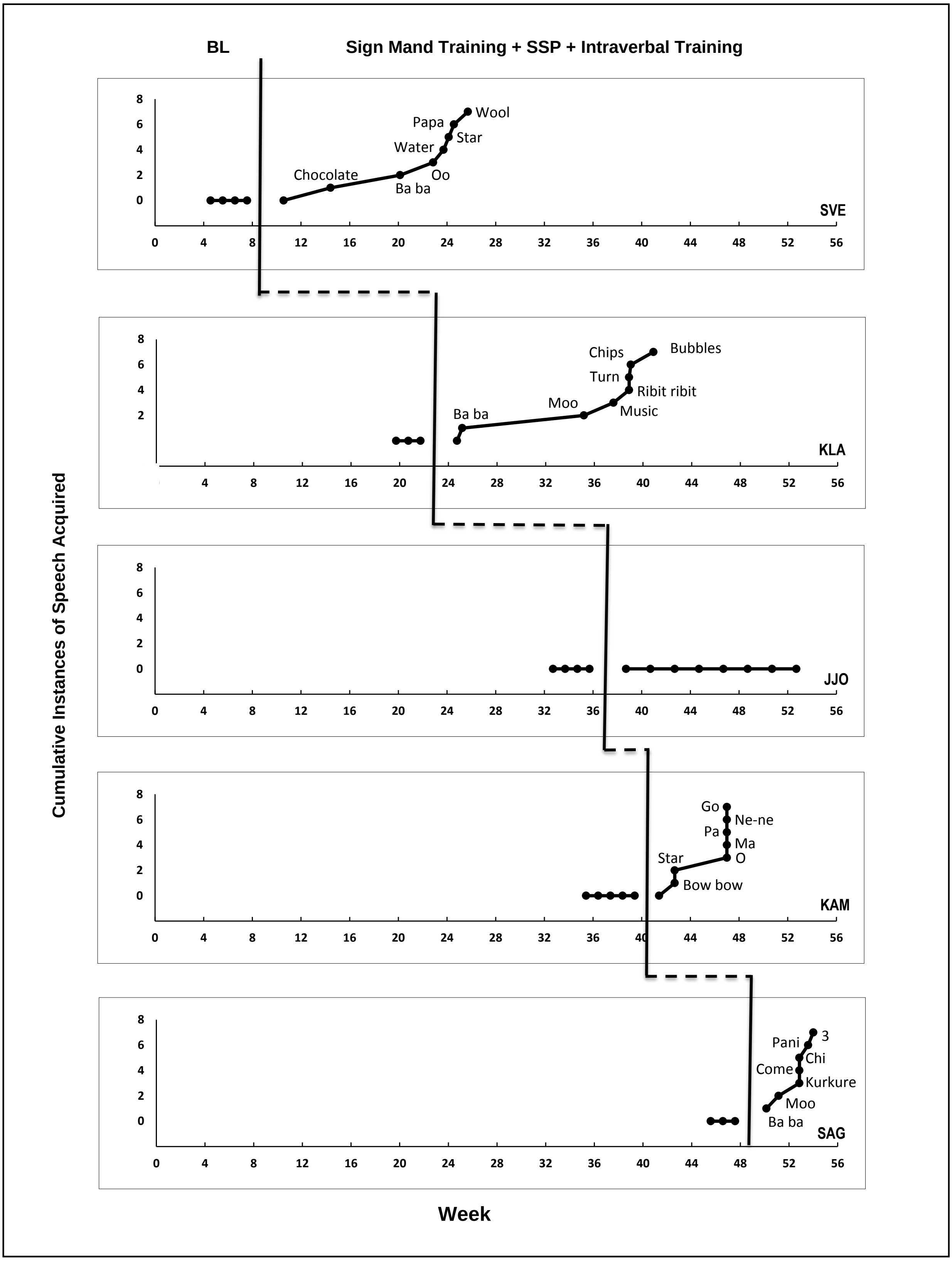

Figure 4.1: A multiple baseline across subjects to study the effect of intraverbal training along with sign mand training with paired vocals in children with autism.

Figure: 4.2 Experiment 4

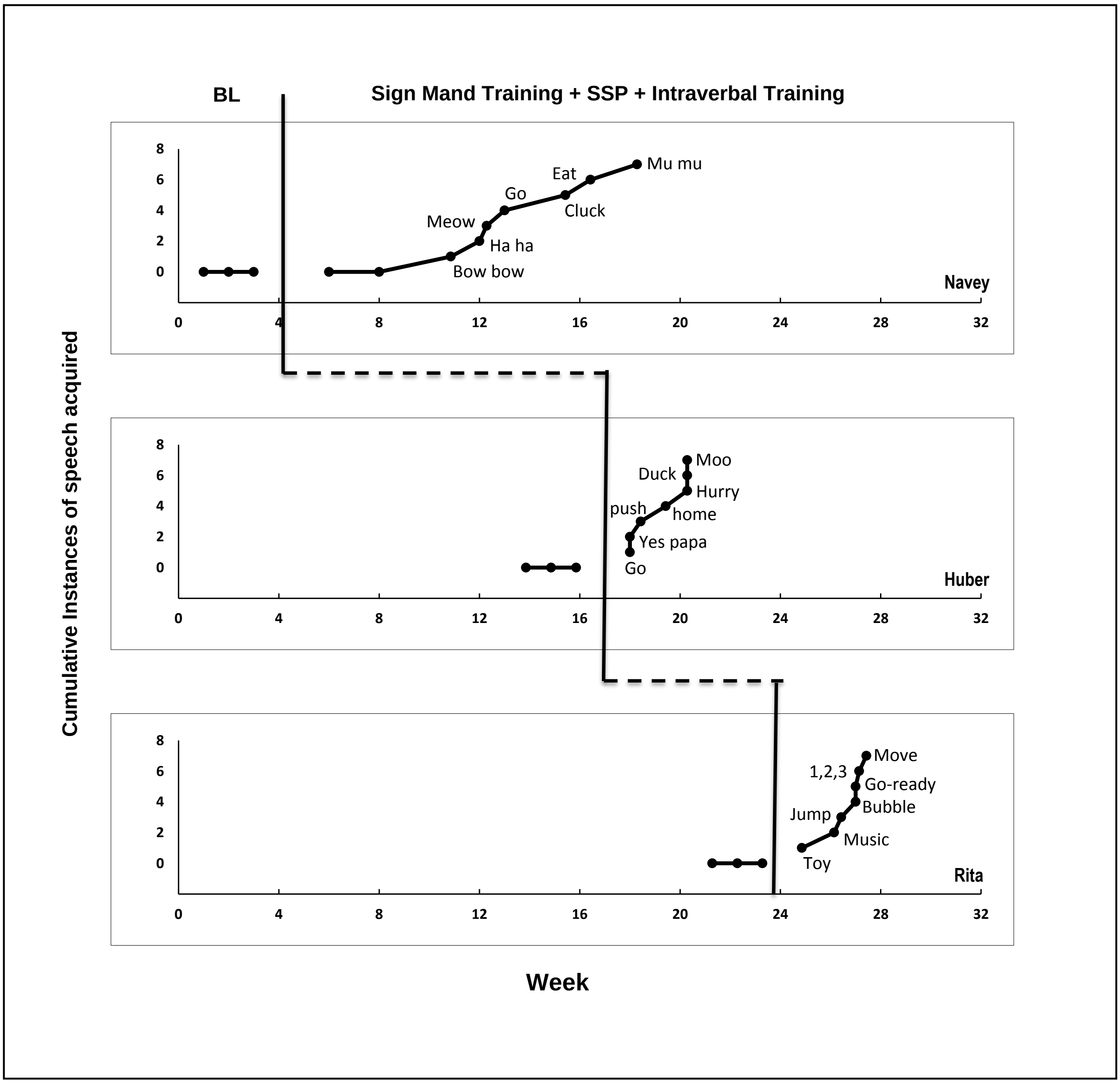

Figure 4.2: A multiple baseline across subjects to study the effect of intraverbal training along with sign mand training with paired vocals in children with autism.

Figure: 4.3 Experiment 4

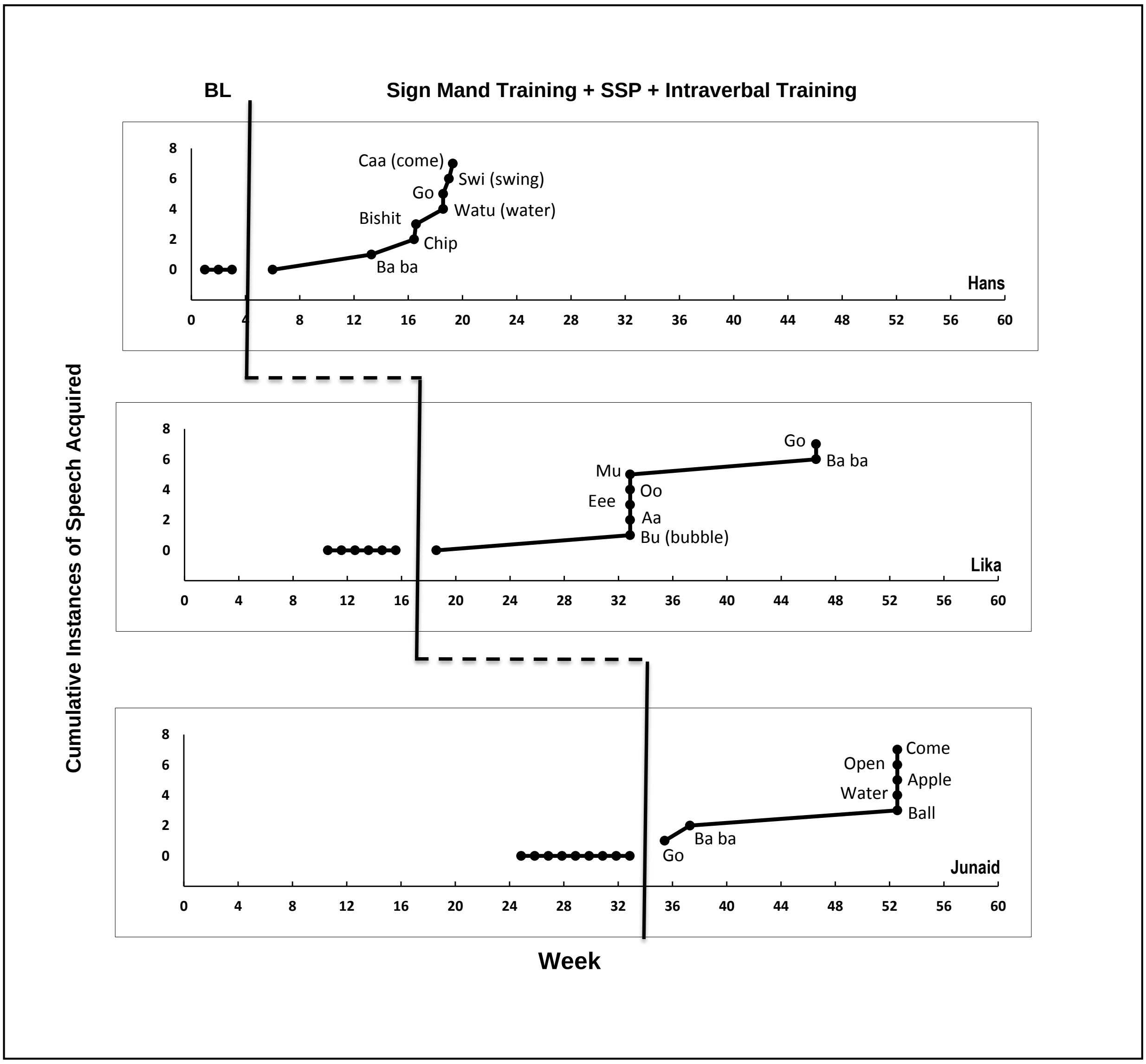

Figure 4.3: A multiple baseline across subjects to study the effect of intraverbal training along with sign mand training with paired vocals in children with autism.

Figure: 4.4 Experiment 4

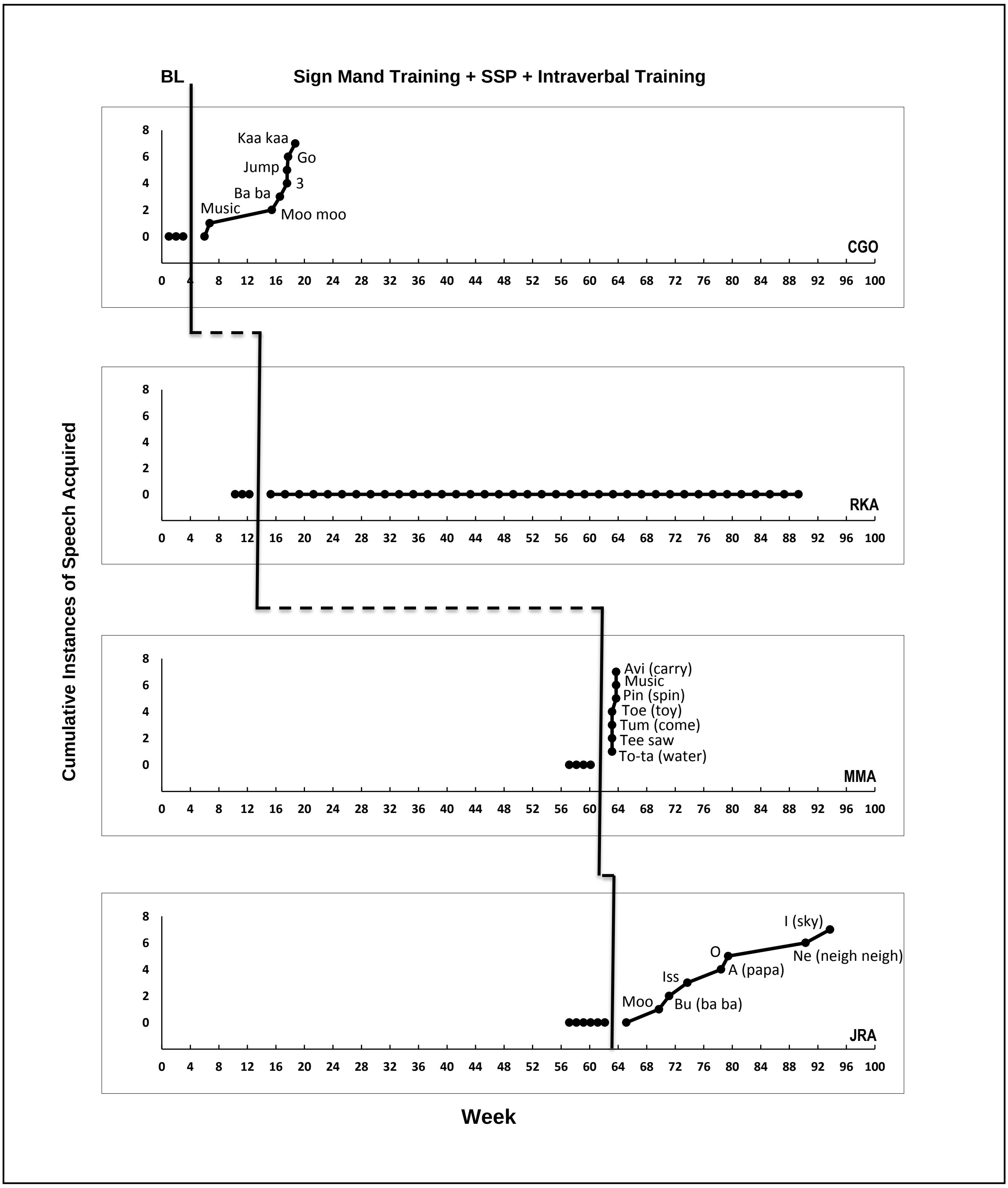

Figure 4.4: A multiple baseline across subjects to study the effect of intraverbal training along with sign mand training with paired vocals in children with autism.

Figure: 4.5 Experiment 4

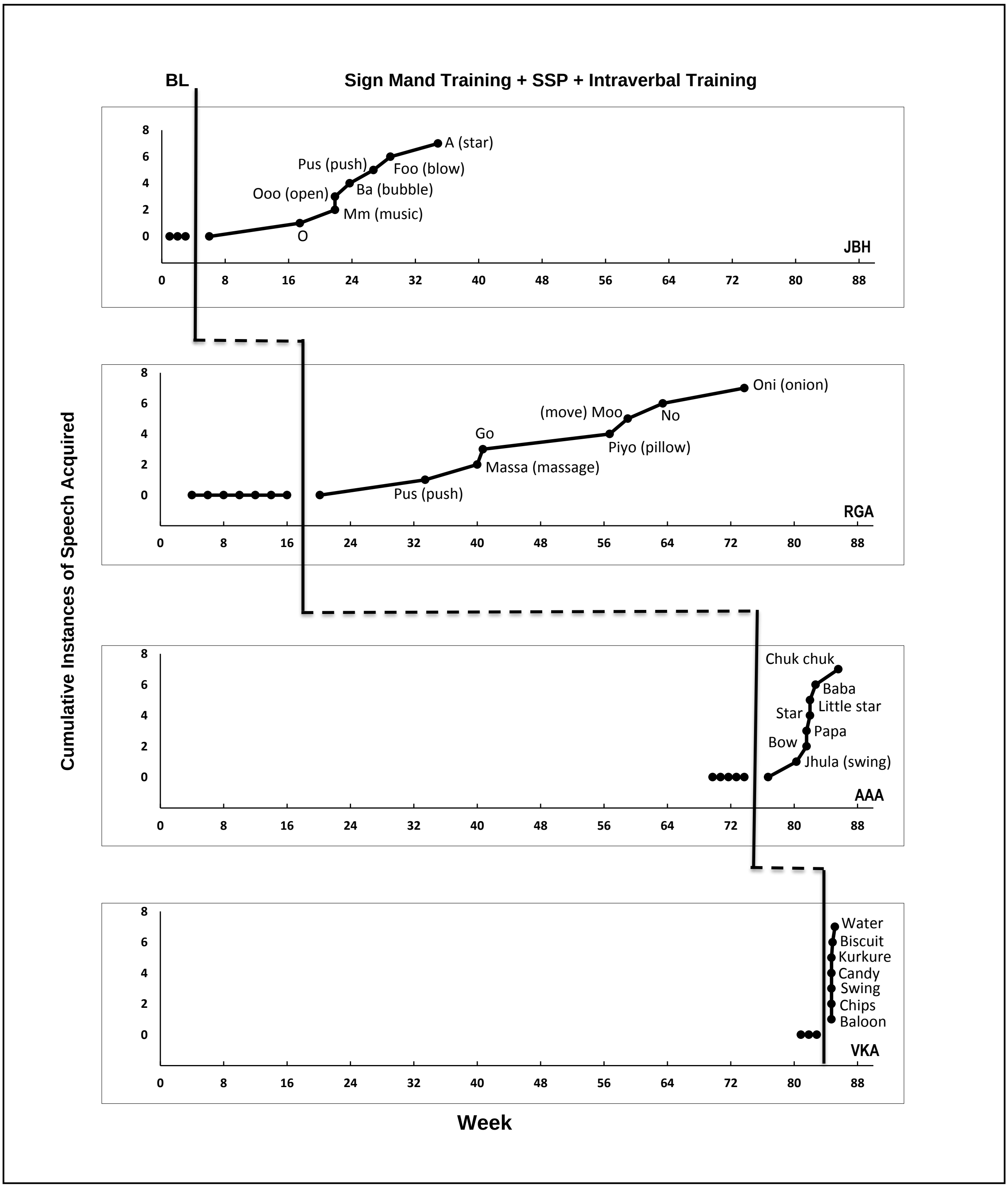

Figure 4.5: A multiple baseline across subjects to study the effect of intraverbal training along with sign mand training with paired vocals in children with autism.

Appendix 4

Behavior Language Assessment

BLA - Experiment 1

Name: Biso Age: 3 Years Date: Feb 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Amaz Age: 2.8 Years Date: Mar.13

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Liv Age: 2.9 Years Date: April 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Digun Age: 4 Years Date: June 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Dako Age: 13.5 Years Date: Aug 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

BLA - Experiment 2

Name: Ashar Age: 5 Years Date: July 13 / Feb 14

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Akon Age: 4.2 Years Date: Nov 13 / Feb 14

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Hipal Age: 5.10 Years Date: May 13 / Apr 14

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

BLA - Experiment 3

Name: Reyan Age: 1.11 Years Date: 20 May 2011
Age: 2.5 Years Date: 5 Dec 2011

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Neha Age: 3.6 Years Date: 10 May 2011
Age: 4 .2 Years Date: 16 Jan 2012

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Barry Age: 3.2 Years Date: 25 May 2011
Age: 4.1 Years Date: 16 Mar 2012

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Mahar Age: 3.5 Years Date: 2 Dec 2011
Age: 4 Years Date: 10 July 2012

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Ricky Age: 3.2 Years Date: 10 Mar 2012
Age: 3.8 Years Date: 15 Sept 2012

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

BLA - Experiment 4.2

Name: Narvey Age: 5.6 Years Date: June 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Huber Age: 5.2 Years Date: Sep 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Rita Age: 4.1 Years Date: October 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

BLA - Experiment 4.3

Name: Hans Age: 2.11 Years Date: Nov 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Lika Age: 2.11 Years Date: March 2014

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: Junaid Age: 5.5 Years Date: July 2014

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

BLA – Single Subject

Name: NPR Age: 5.6 Years Date: Feb 2010

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: RKA Age: 5.6 Years Date: Apr 10

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: AMEH Age: 3.9 Years Date: June 2012

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												

Name: AKE Age: 3 Years Date: June 2013

	Cooperation	Request	Motor Imitation	Vocal Play	Vocal Imitation	Match to Sample	Receptive	Labelling	RFFC	Conversation	Letters and Numbers	Social Interaction
5												
4												
3												
2												
1												